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The evaluation of agri-environmental participatory extension programmes

Jorie Knook

UNIVERSITY OF EDINBURGH
Business School

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The University of Edinburgh
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Declaration of the candidate

The candidate confirms that:

i) the thesis has been composed by the candidate;

ii) the work submitted is her own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below;

iii) the work has not been submitted for any other degree or professional qualification;

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Jorie Knook

Declaration of co-authors

Paper 1 within this thesis '*Evaluation of farmer participatory extension programmes*' was co-authored by the candidate, Dr. Vera Eory, Dr. Matthew Brander and Prof. Dominic Moran. This paper was published in the *Journal of Agricultural Education and Extension* in 2018. The work directly attributable to the co-authors is primarily related to the framing and reviewing of the paper. The remainder of Paper 1 is directly attributable to the candidate.

Paper 2 within this thesis '*An evaluation of a participatory extension programme focused on climate friendly farming*' was co-authored by the candidate, Dr. Vera Eory, Dr. Matthew Brander and Prof. Dominic Moran. This paper was submitted to the *Journal of Rural Studies* in September 2019 and returned in December 2019 with minor revisions required. The work attributable to all the co-authors is related to the framing and reviewing of the paper. Dr. Vera Eory helped in gaining access to the contact details of farmers and in the survey design. Prof. Dominic Moran helped in identifying the case study. The remainder of Paper 2 is directly attributable to the candidate.

Paper 3 within this thesis '*Policy and practice certainty for effective uptake of diffuse pollution practices in a light touch regulated country*' was co-authored by the candidate, Dr. Robyn Dynes, Dr. Ina Pinxterhuis, Dr. Cecile de Klein, Dr. Vera Eory, Dr. Matthew Brander and Prof. Dominic Moran. This paper was submitted to *Environmental Management* in July 2019 and was accepted for publication in December 2019. The paper is currently in press. The work directly attributable to all the co-authors is related to the framing and the reviewing of the paper. Furthermore, Dr. Robyn Dynes and Dr. Ina Pinxterhuis helped in gaining access to the contact details of the farmers and together with Dr. Cecile de Klein they helped in identifying the case study. Dr. Vera Eory, Dr. Robyn Dynes, Dr. Ina Pinxterhuis and Dr. Cecile de Klein helped in designing the interview questions. The remainder of Paper 3 is directly attributable to the candidate.

Paper 4 within this thesis '*Reshaping the culture of farming through participatory extension: An institutional logics perspective*' was co-authored by the candidate and Dr. James Turner. This paper was submitted to *Land Use Policy* in November 2019. On suggestion of the editor it was transferred to the *Journal of Rural Studies* in December 2019. The work directly attributable to

Dr. James Turner is related to the framing and the reviewing of the paper. The remainder of Paper 4 is directly attributable to the candidate.

Dr. Vera Eory

Dr. Matthew Brander

Dr. Robyn Dyne s

Dr. James Turner

Dr. Ina Pinxterhuis

Dr. Cecile de Klein

Prof. Dominic Moran

Abstract

Due to negative impacts on the environment, such as emission of greenhouse gases and pollution of surface and ground water, the agricultural sector has come under increasing scrutiny by wider society. A range of environmental policies and regulations have been developed to create a more environmentally sustainable farming culture, but successful implementation is complex due to the biophysical, economic and social heterogeneity of farms. Therefore, change towards more environmentally sustainable farming has been partially reliant on policies that stimulate voluntary change, such as participatory (research and) extension programmes (PEPs). In PEPs, farmers are participants in knowledge generation and practice change by introducing practices via experimentation on farm and subsequently demonstrating and scrutinising these in discussion groups with peers, experts and researchers.

Given the public investment in PEPs, the increasing requirement for accountability by policy-makers and funding bodies, and the uncertainty around the contribution to environmental targets, it is important that these programmes are reliably evaluated. This thesis addresses the topic of evaluation by: i) presenting a literature review of the current state of PEP evaluation; ii) conducting a mixed-method *ex-post* evaluation of an agri-environmental PEP in Scotland; iii) conducting an explanatory study on farmer decision-making regarding the uptake of environmental practices in New Zealand; and iv) studying the change within the culture of farming in New Zealand and Scotland due to environmental pressures and the role of PEPs in that change.

The findings show that quantitative and qualitative methods are required to comprehensively assess the effect of PEPs beyond practice adoption, as well as longitudinal data collection to correctly quantify the effect of PEP participation. Furthermore, heterogeneity in decision-making factors is observed amongst farmers, which has to be taken into account when designing a PEP. Moreover, achieving sustained environmental change requires more than practice change, such as redefining the values and beliefs guiding farming culture. PEPs can be instrumental in achieving change beyond practice adoption, but additional policy tools, such as regulation and market-based instruments, are required to achieve successful change.

The contribution of this thesis is four-fold: i) it presents one of the first evaluations of climate change PEPs in peer-reviewed literature; ii) it contributes to the development of a mixed methods approach for evaluation; iii) it provides insight into farmer decision-making around water quality issues in countries with low regulation; and iv) it considers PEP evaluation from a novel institutional logics perspective.

Lay summary

The environmental impacts of climate change and water pollution are increasing threats to global sustainability. A number of on-farm activities negatively contribute to both challenges and to address these threats, numerous policies and regulations have been developed. However, due to the presence of many different farm types (activities, sizes), effective change via regulation has been difficult to achieve. Therefore, change towards more environmentally friendly farming is partially reliant on voluntary policy approaches including participatory extension programmes (PEPs). In PEPs farmers, researchers, extension experts and other relevant stakeholders learn together by conducting experiments and demonstrations on farms, and subsequently discussing these in a group setting. Although these PEPs are gaining popularity, there is limited evaluation on how well they are contributing to environmentally friendly farm management practices. To explore this gap this thesis applies evaluation theories and methods, to conduct a holistic evaluation of agri-environmental PEPs.

The evaluation topic is addressed in four papers. Paper 1 presents a literature review of the current state of PEP evaluation. It identifies that the majority of the evaluations have been: conducted in developing countries; included outcome indicators to quantitatively evaluate the effectiveness of the PEP; focused to a limited extent on the views and perspectives of farmers. Paper 2 addresses the gaps identified in Paper 1 by conducting an evaluation of a climate change PEP in Scotland using a mixed method evaluation to address the views and perspectives of farmers, instead of only a quantitative evaluation to measure practice adoption. The study shows that farmers who are participating in the PEP have a higher degree of practice adoption, but interviews show that farmers themselves do not attribute this increased adoption to the PEP. Paper 3 addresses the farmers' views and perspectives on the uptake of water quality practices. By interviewing PEP and non-PEP farmers in New Zealand, decision-making factors influencing practice adoption were identified. The paper shows that there is a wide variety of factors relevant to farmers and this is addressed by the creation of a farmer typology. Different support options are suggested for these farmer types and it is suggested that these differences should be taken into account in PEP design. The paper also highlights the importance of the use of a set of policy approaches to ensure change by all farmer types. Paper 4 looks at the changes that occur in

practices, beliefs, and values, to identify to what extent sustained change might have been initiated due to PEP participation. The study shows that practices change, but the beliefs and values mostly do not. The study concludes that in addition to change in practices, achievement of sustained environmental change also requires redefinition of values and beliefs guiding farming culture. PEPs can contribute to this change by several mechanisms, including creating a support network for farmers in which they can experiment with new practices.

The final section of the thesis places the findings of the papers in a wider perspective and concludes that a PEP alone is not sufficient to achieve successful change in complex issues such as climate change and water quality. Timing of PEP implementation, as well as additional policy tools, such as regulation and market-based instruments, are required to achieve this change.

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1. Introduction

1.1 Initial overview

The agricultural sector is responsible for approximately 25% of global greenhouse gas (GHG) emissions (IPCC, 2014; Le Quéré et al., 2016) and associated with other environmental impacts, such as contributing to surface and groundwater pollution (De Klein and Ledgard, 2005). Governments recognize the importance of changing on-farm practices to minimise environmental impacts (Ministry for the Environment New Zealand, 2013; The Scottish Government, 2017). To stimulate behavioural change and practice adoption by farmers, a range of policy instruments have been applied, such as regulatory frameworks and market based instruments (Greiner and Gregg, 2011; Lockie, 2013). The implementation of these instruments is, however, complex due to the biophysical, economic and social heterogeneity of farms (Darnhofer et al., 2012a). Therefore, policy instruments that provide advice and develop new technologies and practices, while including the views of farmers and support of researchers and experts, have been favoured (P. Brown et al., 2016; Vrain and Lovett, 2016). An example of such a policy instrument are participatory (research and) extension programmes (PEPs), which aim to stimulate practice adoption, social learning, resilience to challenges and uncertainties, and management skills and decision-making (Black, 2000; Cristóvão et al., 2012). PEPs ideally do not only lead to the adoption of new practices, but also to sustained change in farmers' beliefs and values.

Participatory extension has been associated with high rates of practice adoption; a positive impact on productivity and income; an increase in knowledge and skills; and good availability of peer support (Davis et al., 2012). These findings are mostly derived from quantitative *ex-post* evaluations, focused on performance indicators, such as economic and environmental programme outcomes (Knook et al., 2018). However, it is questioned whether these evaluations sufficiently measure all aspects of PEPs, or solely focus on practice change (Munro, 2014). For example, social learning is an aspect that these quantitative *ex-post* evaluations fail to take into account.

Given the public investment in PEPs, the increasing requirement for accountability by policy-makers and funding bodies, the uncertainty around the (potential) contribution to environmental targets, and the doubts about whether current extension design meets farmers' needs (Sewell et al., 2017), it is important that suitable evaluation techniques are developed for these programmes (Faure et al., 2012; Klerkx et al., 2016). EU member states have set up evaluation guidelines for their Rural Development Programmes, including recommendations on method use (European Commission, 2015, 2010; HM Treasury, 2011, 2003), but limited work has been published in the scientific literature on the development and use of evaluation techniques for environmental PEPs in developed countries.

To address the above issues and identify how to conduct a comprehensive evaluation of PEPs, this thesis focuses on the evaluation of agri-environmental PEPs. This initial overview is meant to provide an understanding of the main topic and sub-topics explored in this thesis, with further discussion on the coherence, literature and perspectives that have influenced the research outlined later in this chapter. The thesis is a portfolio of four papers, with an introductory chapter and a concluding chapter. The papers in this portfolio are listed in Table 1 below.

Table 1. Papers in portfolio, authors, journal, and publication status

Paper number	Title	Authors	Journal	Publication Status
1	Evaluation of farmer participatory extension programmes	Knook, J., Eory, V., Brander, M., Moran, D.	The Journal of Agricultural Education and Extension	Published in April 2018.
2	The evaluation of a participatory extension programme focused on climate friendly farming.	Knook, J., Eory, V., Brander, M., Moran, D.	Journal of Rural Studies	Published in May 2020.
3	Policy and practice certainty for effective uptake of diffuse pollution practices in a light touch regulated country	Knook, J., Dynes, R., Pinxterhuis, I., de Klein, C.A.M., Eory, V., Brander, M., Moran, D.	Environmental Management	Published in December 2019.
4	Reshaping the culture of farming through participatory extension: An institutional logics perspective	Knook, J. & Turner, J.	Journal of Rural Studies	In second round of revision in Journal of Rural Studies.

The research in Paper 1 was set out to inform the data collection in the subsequent research. It has directly informed the choice of methods for the *ex-post* evaluation conducted in Paper 2 and identified a lack of explanatory evaluation studies, which is addressed in Paper 3. Paper 4 investigates a gap identified in Paper 2: the lack of measurement of long-term change. It uses data collected in both Scotland and New Zealand to gain insights into the cultural embeddedness of environmental practices, beliefs and values due to PEP participation. The research questions addressed in this thesis are as follows:

1. What is the current state of practice regarding the evaluation of PEPs?

   A literature review has been conducted to seek understanding into the current state of practice regarding the evaluation of PEPs. The paper contributes to current literature by identifying gaps in the *ex-post* evaluation of PEPs. Subsequently, this knowledge is used to guide research in the subsequent papers in this thesis.

2. How can both environmental and human-social factors be evaluated for an agri-environmental PEP?

   A mixed methods *ex-post* evaluation has been conducted on a PEP in Scotland, which focused on the reduction of farm-level GHG emissions. The programme was evaluated by measuring the four main PEP aspects: practice adoption, social learning, resilience to challenges and uncertainties, and farmers' management skills and decision-making abilities. The paper adds to the current literature by studying the functioning of PEPs in a developed country context; by incorporating both environmental indicators and human-social aspects; and by combining qualitative and quantitative methods to evaluate the four aspects of the PEP.

3. Which factors influence farmer decision-making around the uptake of diffuse water pollution reduction practices?

   Semi-structured interviews and observations of farm meetings were conducted with PEP farmers, PEP network farmers and non-PEP farmers to gain insight into the main decision-making factors regarding the uptake of diffuse water pollution reduction practices in a light-touch (a country with limited government intervention in the agricultural sector) policy country. Based on the heterogeneity in factors influencing farmer decision-making a

typology of farmers was developed. The paper adds to the current literature by identifying decision-making factors for a light-touch regulated country; providing recommendations on extension in light-touch policy countries; and using the typology to provide recommendations for extension with different types of farmers.

4. Does participation in a PEP induce a change in institutional logics?

Semi-structured interviews and observations of farm meetings were conducted in both Scotland and New-Zealand to: i) analyse how the culture of farming has changed due to the need to adopt more environmentally friendly farming practices; ii) identify the mechanisms via which this change unfolds; and iii) identify how PEPs can contribute to successful change. The institutional logics perspective was used to study the change in the culture of farming. The study contributes to current literature by introducing a new lens to understand change in farming culture. A practical contribution is made by providing agricultural change agents, such as extensionists, with more in-depth knowledge about farmer values, beliefs and practices. This will help in how to communicate, frame, and organise extension initiatives.

The papers included in this portfolio are the versions that are published or submitted for publication, although minor changes have been made to create a coherent document, such as renumbering of figures and tables. The remainder of this chapter is structured as follows. Firstly, a description of the central topic of the thesis, participatory extension programmes, is given. Then, the personal perspective of the researcher and how it has been influenced by other actors, such as supervisors and peers, is outlined. This is followed by an overview of the research perspectives that have influenced the research design. This chapter concludes with an overview of each paper and how they link together.

1.2 Participatory extension programmes: defining the concept

1.2.1 Terminology

Throughout this thesis the term 'participatory extension programmes' will be used to refer to programmes that apply participatory extension methods, such as on-farm demonstrations, experiments and discussion groups, to actively engage researchers, extension agents, farmers, and other relevant stakeholders in not only challenging and developing on-farm management for farmers, but also in for example identifying research topics for researchers. There is a wide range of terms that has been used for these participatory extension programmes in the literature, synonymous terms are for example 'farmer first' (e.g. Chambers et al., 1989), 'farmer field schools' (e.g. Kraaijvanger et al., 2016; Rejesus et al., 2009), 'participatory innovation platforms' (e.g. Kilelu et al., 2013), 'innovation systems' (e.g. Dolinska and d'Aquino, 2016) and 'co-innovation projects' (e.g. Vereijssen et al., 2017). In this thesis the term 'participatory extension programmes' is adopted because it is a collective term that represents the wide range of programmes, which all include an approach in which farmers are participants in research and extension.

1.2.2 Development of participatory extension programmes

The participatory extension approach originated in the 1980s as an alternative to the linear 'transfer-of-technology (TOT) paradigm' (Chambers et al., 1989). The TOT paradigm was characterised by a positivist framework, in which objective experimental research was conducted by scientists who were responsible for setting the research agenda. Subsequently, after developing the research at research stations, the scientists communicated the outcomes to extension agents, who then communicated these to farmers. The uptake of practices was mainly assumed to rely on social interactions. Therefore, communication between extension agents and farmers and then farmers to peers was seen as sufficient to successfully diffuse the practice amongst all farmers (Rogers, 2003).

However, in the 1980s this approach received various critiques, such as: failing to account for local complexity; lacking a farmers' perspective (Pretty, 1995); failing to account for knowledge in the development and dissemination of practices (Pretty and Chambers, 1993); and not

providing sufficient return on investment (Feder et al., 1999). As a response to these critiques, participatory extension approaches became popular at the end of the 1980s. One of the first formalised participatory initiatives was called 'Farmer First' (FF) (Chambers, 1993). FF initiated a change from a positivist to a holistic extension outlook, in which new ways of learning were stimulated that included local complexity, diversity, and uncertainty, leading to farmer self-development (Ison, 1990). To achieve change, extension agents were encouraged to move away from working within one discipline on research stations and focusing on the transfer of technology and practice in one context, to being inclusive of multiple disciplines, entering close dialogue with scientists as well as farmers and addressing the complexity of local context in practice development (Chambers, 1993).

Pretty and Chambers (1993) list three key aspects for successful participatory extension: i) the use of participatory approaches and methods to allow the support of local innovation and adaptation, which allows the incorporation of diversity and complexity and the stimulation of local capabilities (Lauzon, 2013); ii) the design of an interactive learning environment to stimulate collaboration between all actors, i.e. scientists, experts and farmers, which by social learning and joint negotiation lead to problem solving and the co-construction of new knowledge (Dolinska and d'Aquino, 2016; Kilelu et al., 2013; Sewell et al., 2017); and iii) the provision of institutional support, which is translated in new linkages between institutions, as well as support in a material way, by e.g. providing and supporting platforms for discussion and disseminating the outcome of the discussion groups. Based on these key aspects, different variants of participatory extension were developed. For example, the Farming Systems Research (FSR) perspective focuses on the first two aspects outlined by Pretty and Chambers (1993), by looking at the partnership between farmers, technical and social scientists, extension agents and policy actors (Pant and Hambly-Odame, 2009). In this approach the focus is on the direct biophysical and socioeconomic context of the farms and farm groups, and only these contexts need to be taken into account to achieve a change in farm management. This approach is similar to the participatory extension programme in Scotland included in this thesis. More information on this programme will be provided in Paper 2 and 4.

Another variant of participatory extension is called Agricultural Innovation Systems (AIS). AIS states not only the direct biophysical and socio-economic context of farms should be taken into

account in achieving change, but also the institutional context (Dolinska and d'Aquino, 2016). This institutional context consists partly out of laws and regulations, and partly out of norms and values that determine 'the way things are done'. This institutional context is known to influence values, beliefs and practices adhered to in farming (Klerkx et al., 2012). To challenge the practices, beliefs and values of farming different stakeholders are included in the programmes, such as researchers, extension agents, and actors from the private sectors, for example from seed companies or banks (Hall et al., 2002). The design of the PEP in New Zealand included in this thesis was based on this AIS perspective. More information on this programme will be provided in Paper 3 and 4.

1.2.3 Evaluation of participatory extension programmes

Evaluation is important for showing the success of an approach to funding bodies and other professionals, for the functioning of the programme itself, and the design of future programmes. In the PEP literature most evaluations have been outcome oriented, by for example measuring the economic return on investment or yield increments (Knook et al., 2018). This outcome oriented set of evaluation methods have been suitable for the TOT model of extension, which has transfer of technology as its central objective and therefore evaluation methods solely measuring the adoption of practices are suited. However, these outcome-oriented methods do not reflect all the aims of PEPs, because these evaluation methods do not include an evaluation of the learning and development of the participating farmers (Allen, 1997; Vanclay and Lawrence, 1995). Therefore, it is argued that the rejection of the TOT model has left a void in evaluation (Murray, 2000). Although this point has been raised years ago (Murray, 2000), quantitative outcome oriented evaluations are still the dominant way to evaluate PEPs. The increasing complexity of problems presented to farmers, such as changing farm management to address diffuse pollution problems, requires a participatory solution. But as long as current evaluations fail to reflect changes beyond practice adoption due to PEP participation it is unknown how to best develop these programmes. Therefore, this thesis aims to address this gap in literature.

1.3 Personal perspective

The research for this thesis has been conducted under supervision of an interdisciplinary supervisory team; in different countries, i.e. Scotland and New Zealand; within different research institutes, i.e. the University of Edinburgh, Scotland's Rural College (SRUC), and AgResearch; and in collaboration with different organisations, i.e. the Scottish Government and DairyNZ. Before outlining the research perspectives that have influenced the thesis in the next section of this chapter, I would like to elaborate on the development of my personal perspective, e.g. my worldviews, and how this has influenced the research design.

Worldviews can be explained by ontology and epistemology, which are concepts derived from philosophy. Ontology considers 'what exists' and epistemology focuses on 'what we can know about what exists' (Huff, 2009). Having a certain ontological and epistemological worldview has implications for research design, such as the choice of questions and methods. Gibson & Morgan (1979) created a classification of the basic differences in worldviews. In this classification there is an ontological distinction between realism and nominalism. Realism posits that everything can be expressed as physical, measurable material. Nominalism on the other hand posits that abstract concepts do not exist in physical or tangible material. Epistemological worldviews are often categorised as being either 'positivist', in which the researcher can objectively conduct research by removing all contextual factors that cause human bias, and 'antipositivist', in which it is not possible to create objective knowledge, but researchers can report on their own experience. These ontological and epistemological worldviews lead to a difference in methodological approach: 'nomothetic', in which it is the aim to obtain objective knowledge through scientific methods; and 'ideographic', in which the researcher focuses on individual cases and aims to get 'inside' the subject.

The initial ontological position of this research was a realist model. This view was based on my background in natural science, in which the use of objective methods and an independent position of the researcher is the scientific standard. According to this model, the initial research focus of the thesis was on objective, mostly quantitative methods to independently evaluate the effect of PEPs. This aligned with the dominant evaluation perspective of PEPs, which is mostly based on evidence-based policy (Munro, 2014).

However, this realist model did not allow the inclusion of the complexity of different local contexts, which could explain why a PEP in a certain environment worked while not in others. Therefore, I developed doubts about whether applying quantitative methods would be sufficient to provide a holistic PEP evaluation. The main influence that led me to question the realist model was following classes in political science, in which it was discussed how a certain worldview, e.g. the realist model, can limit the questions studied. An objective methodological approach such as a quasi-experimental *ex-post* evaluation approach, could have limited the evaluation questions, because the approach only focuses on the effectiveness of the programme, e.g. is the investment worth it? However, measuring 'effectiveness' by applying a (quasi-)experimental research design was the approach to evaluation used for the TOT extension model and did not reflect the 'participatory' aspect of the PEPs, i.e. only practice adoption was addressed and the aims of social learning, resilience to challenges and uncertainties, and management skills and decision-making were ignored. Therefore, to conduct a holistic evaluation it was necessary to reflect on and include the farmer' perspective on the PEPs (Paper 2, 3, and 4). Applying a wider range of methods and theories, such as semi-structured interviews, participant observations, and institutional theory, allowed me to place the effects of PEP participation in a wider context, by understanding the views and interpretations of farmers I worked with.

The different requirements and viewpoints I encountered made me realise that my worldview and research perspective does not align with either the realist or nominalist model. This led me to adopt the 'pragmatist' worldview. In this worldview the ontological and epistemological distinctions between realism and nominalism are rejected and the focus is on the model of inquiry (Dewey, 2008). This model states that a problem should be recognised, consequently the nature of the problem should be analysed, leading to a reflection on the choice of actions to address the problem. Hence, pragmatism replaces the classical distinction between ontologies and epistemologies by focusing on the question, and basing the selection of a theory and methodology to the type of question being asked (Morgan, 2014). This allows me to use both quantitative and qualitative methods, and approach questions with different theoretical lenses.

1.4 Research perspective

The section below gives a brief introduction to the research perspectives and theories that have been used to answer the questions in the thesis. This section will be summarised by explaining how each of the perspectives and theories have informed the papers included in this thesis.

1.4.1 The perspectives on evaluation

Evaluation has become a legitimate and important field of social research with increasing attention from researchers and policy-makers (McCoy and Hargie, 2001). This has resulted in evaluation not only serving a learning purpose, but also a governance role as evidence provider. An increasing emphasis on accountability in the public sector has led evaluation to be considered fundamental, almost obligatory, for PEPs, and is often considered as a prerequisite for funding (Davies, 1999; McCoy and Hargie, 2001). Evaluation methods in public policy are well-established for both *ex-ante* and *ex-post* evaluations in the EU Commission and multilateral agencies (European Commission, 2015, 2010; HM Treasury, 2011, 2003). However, there is little scientific literature focusing on the evaluation of agri-environmental PEPs and thus there is a lack of debate in the literature on how to conduct a good evaluation that provides insight into how these programmes contribute to environmental targets and behavioural change of agricultural stakeholders, such as farmers and extension agents. This section aims to provide an overview of evaluation perspectives.

1.4.1.1 Ex-ante evaluation

Although the majority of PEP evaluations have been conducted *ex-post*, there is some literature that aims to identify the needs and requirements for the implementation of extension services. *Ex-ante* evaluation refers to evaluation conducted before programme implementation. These evaluations aim to support optimal programme design at minimised cost; avoid implementation costs of programmes that turn out to be ineffective; and provide insight into expected impacts after implementation to help *ex-post* evaluation design (Todd and Wolpin, 2006). To address these aims, mostly quantitative evaluations are conducted, with often a focus on the potential return on investment of the programme (Smismans, 2015). However, by only focusing on

economic efficiency in evaluation, limited improvements can be made to current programme design and social advancement (Henry, 2004).

1.4.1.2 Ex-post evaluation

Ex-post evaluation refers to evaluation conducted after programme completion. In these evaluations there is no focus on changes for the programme itself, but on the effectiveness and learnings from the programme, which are often used for future programme design. Most evaluations of PEPs in scientific literature are *ex-post* evaluations.

The dominant way of conducting *ex-post* evaluations of PEPs has been by applying quantitative experimental methods (Ison, 1990; Knook et al., 2018), by using causal inference theory (e.g. Läpple et al., 2013; Sanglestsawai et al., 2015). Most studies show a positive return to programme participation in terms of an increase in financial performance or productivity. Although this experimental approach allows testing the outcome-oriented objectives of the programme, it excludes contextual factors. Therefore, the dominant quantitative evaluation perspective is criticised for falling short of a holistic evaluation of a PEP (Knook et al., 2018; Murray, 2000). Prager & Creaney (2017) and Sewell et al. (2017) are two of few studies that go beyond adoption rates, to include a qualitative evaluation of levels of learning and knowledge, which are important indicators to provide insight into long term behavioural change (Muro and Jeffrey, 2008).

1.4.1.3 The evidence-based policy perspective

Evidence based policy (EBP) aims, by rigorously established objective evidence, to drive policy makers towards a more rational way of decision-making. Over the past decades EBP has become considerably more popular (Cartwright and Hardie, 2012; Davies et al., 2000). This is due to: the growing scepticism on the expertise of professionals (Cartwright, 2009; Munro, 2014); data availability; the urge of politicians to find 'real' knowledge (Munro, 2014); and calls from prominent researchers, such as Nobel prize winners Ester Duflo and Abhijit Banerjee, to provide scientific evidence for the development of policy programmes (J-PAL, 2019). EBP addresses these needs by applying a positivistic epistemology, in which policy makers are informed by developing objective and universal knowledge about the social world. The gold standard to achieve this

objective knowledge in social science is by applying (quasi-) experimental designs such as randomised controlled trials (Guo et al., 2015), difference-in-differences (e.g. Rejesus et al., 2012), and propensity score matching (e.g. Läpple and Hennessy, 2015).

Although EBP is a popular view on evaluation there is also criticism. It is for example questioned whether the results from EBP limit the questions studied (Munro, 2014). The (quasi-) experimental research designs cannot provide an answer to all areas of knowledge, such as social learning (Muro and Jeffrey, 2008). Without being able to measure the motivations behind farmers' practice change it is difficult to identify their perspective on the environment and identify whether environmental practices have become embedded within the culture of farming. Therefore, Davies (2000) and Montuschi (2014) argue that EBP should start valuing both qualitative and quantitative research data for evaluation.

1.4.2 Social learning theory

As noted above, in the literature on PEP evaluation there are only a limited number of studies that look beyond practice adoption. One of the essential aspects of participatory extension is social learning (Muro and Jeffrey, 2008; Sewell et al., 2017). Social learning is defined as communication and interaction of different actors within a participatory setting, which results in social outcomes, such as knowledge generation, acquisition of technical and social skills, and the development of trust and relationships (Muro and Jeffrey, 2008). The development of trust is essential in achieving change via for example double loop learning, where participants of the PEP, such as peers, experts and researchers, suggest new ideas that via recurrent discussion and experimentation lead to reshaping farmer identities, behavioural beliefs, and assumptions (Argyris and Schon, 1996; Inman et al., 2018).

As highlighted earlier in this chapter, there is a limited number of studies that includes indicators such as social learning in the evaluation of PEPs (e.g. Sewell et al., 2017), whereas it is an essential part of PEPs. This indicates a gap in scientific PEP evaluations.

1.4.3 Institutional theory

There is a lack of studies that measure the change in farming culture due to PEP participation. Farming culture can be seen as an institution for which change can be measured. Institutional

theory focuses on institutions, 'the unwritten rules, norms, values and culture which determine the way 'business is done' (Klerkx et al., 2012). These institutions are known to play an important role in the (in)ability to establish change at an organisational or field level. Institutional change has been a prominent topic of research in organisational studies (Micelotta et al., 2017), political sciences, and sociology (Clemens and Cook, 1999; Mahoney and Thelen, 2009). It looks at the processes by which institutions become established as guidelines for social behaviour and consequently, at the change that occurs in these institutions. One of the developing lines of research in organisational sciences suggests that institutional change derives from shifts in institutional logics (Goodrick and Reay, 2011; Greenwood et al., 2011; Lounsbury and Beckman, 2015). These logics consist of practices, beliefs and values which together shape the 'rules of the game' (Thornton, 2004).

The majority of the literature on institutional logics has focused on sudden and large changes at a field-level, i.e. a whole sector (Micelotta et al., 2017). It is however acknowledged that change can also start at an individual-level and diffuse slowly (Thornton and Ocasio, 2018). For example practice-level change, which begins with organisational practice change, leads to an institutional change by initiating changes in beliefs and values, and practices then diffuse to other organisations and eventually to field-level (Smets et al., 2012). However, there is only limited understanding about how this change unfolds. Previous studies (e.g. Gray et al., 2015; Smets et al., 2012) have identified mechanisms contributing to institutional change from a practice-level, but research has not been done on how practice level programmes, such as PEPs, can contribute to change by using this practice level approach.

1.4.4 Grounded theory

Grounded theory assumes that the organisational world is socially constructed, which means that the notion and meaning of things are developed in coordination with others, instead of by an individual. Furthermore, it assumes that individuals within an organisation know what they are trying to do and are able to capture this in thoughts, intentions and actions (Gioia et al., 2013). Consequently, it is the role of the researcher to report on those thoughts, intentions and actions and to depict the voice of the interviewees in the research (Thornberg and Dunne, 2019). Although studies are conducted identifying the attitudes of farmers towards certain issues (e.g.

Barnes and Toma, 2012), predefined statements have been used. A grounded theory approach, in which theory is developed from the patterns in the collected data, can be used to provide new insights into the factors constituting farmer decision-making in relation to the voluntary uptake of unsubsidised diffuse pollution practices. The grounded theory approach, also referred to as the inductive approach in Paper 3, is not governed by previous theory and therefore allows the inclusion of the wide range of factors influencing farmer decision-making without dismissing any diverse meanings that may emerge from the interviews and observations.

1.4.5 Theories and research questions

This section describes which theories and perspectives have influenced each of the papers/chapters in this thesis. An overview of which perspectives and theories have influenced the research questions is depicted in Figure 1. The figure does not include paper 1 (Chapter 2), which will be discussed in more detail in section 1.5.

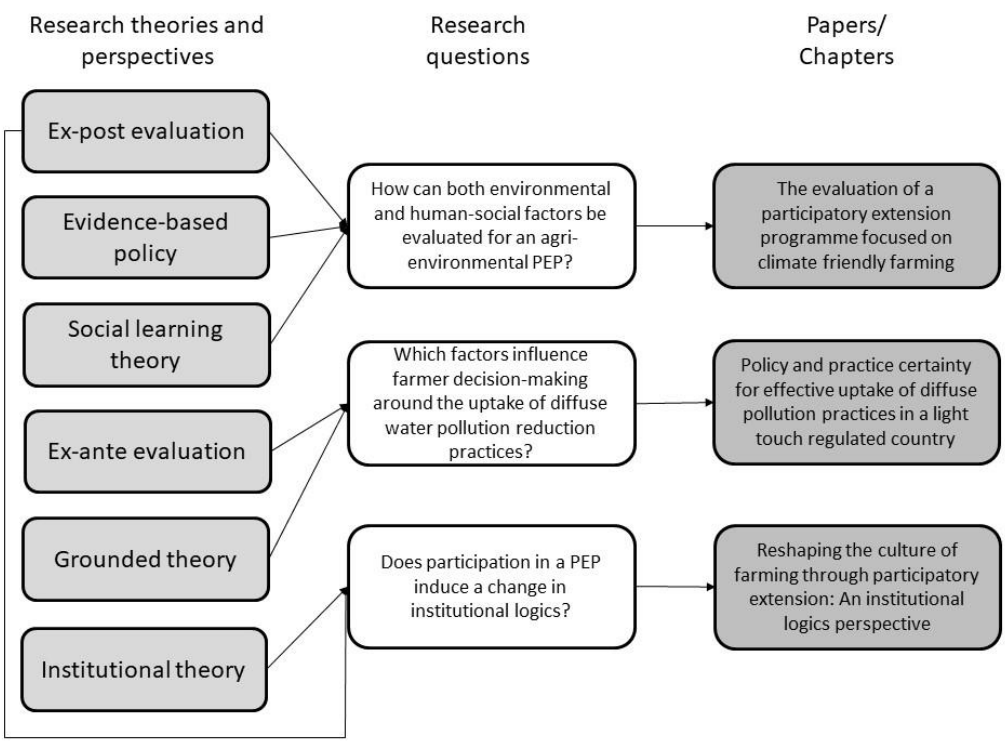

Figure 1. Overview of theories that influenced research questions and outputs (papers/chapters)

The dominance of quantitative *ex-post* evaluations and the EBP perspective on PEP evaluation caused me to apply the ex-post evaluation perspective by applying causal inference theory to determine the impact of programme participation on outcome indicators. A quasi-experimental evaluation method has been applied to the PEP in Scotland, described in Paper 2 (Chapter 3). However, the criticism and limitations of a quantitative *ex-post* evaluation led to the inclusion of a qualitative evaluation method, based on social learning theory. Social learning and other participatory indicators, such as management skills, were measured by conducting qualitative interviews with the aim to reflect the participatory aspect of the PEP.

After designing the initial evaluation for the PEP in Scotland, it became apparent that there is a lack of explanatory studies into the decision-making factors around the uptake of diffuse pollution practices in light-touch policy countries. This influenced the research design for the PEP analysis in NZ, which is described in Paper 3 (Chapter 4). Interviews were conducted with PEP and non-PEP farmers to identify farmer motivations and understanding of the nitrate leaching issues in New Zealand. Consequently, grounded theory was used to systematically identify factors influencing decision-making around the uptake of nitrate leaching practices. Although grounded theory is applied in the paper, in Paper 3 this is described as an 'inductive approach'. The reason for using the terminology of 'inductive approach' instead of 'grounded theory' is based on feedback from reviewers, who indicated that this terminology is preferred by the journal's audience when describing a grounded theory approach.

Lastly, there was a lack of evaluation methods to measure sustained change after PEP (ex-post) participation, which sparked my interest in applying the principles of institutional logics to measure institutional change. By looking at how change unfolds at an individual-level, at how this may reshape beliefs and values regarding 'good farming' at an individual and field-level, and what role a PEP can play therein, sustained change was measured. This evaluation is presented in Paper 4 (Chapter 5) of the thesis.

1.5 Relationships between the papers

To increase understanding into the overarching themes and connections between the papers, this section provides a summary of each paper and the relationship between them (Fig. 1).

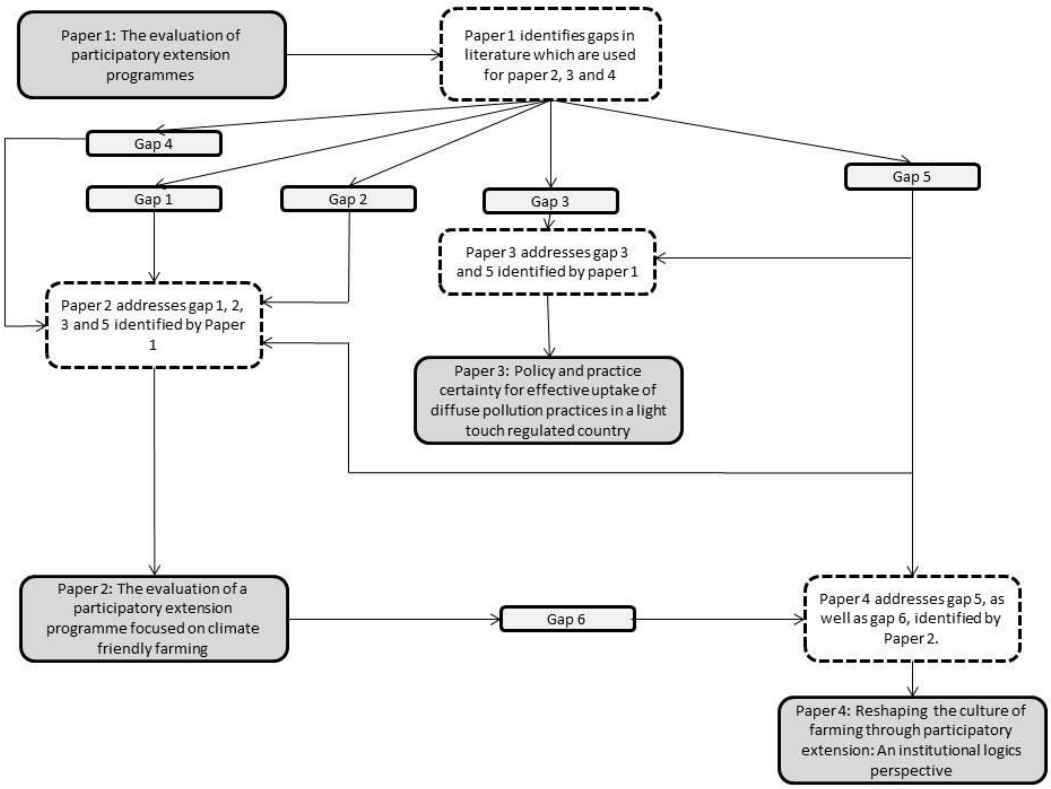

Figure 2: Overview of the relationship between Paper 1, 2, 3, and 4. Gap 1 refers to the lack of qualitative evaluations of PEPs; gap 2 refers to evaluations incorrectly accounting for endogeneity and selection bias; gap 3 refers to the lack of evaluation planning before PEP initiation; gap 4 refers to the lack of environmental impact outcomes included in evaluation; gap 5 refers to the lack of evaluations conducted in developed countries; and gap 6 refers to the lack of evaluation indicators to measure long term change.

1.5.1 Paper 1

Evaluation of farmer participatory extension programmes. The paper has been published in *the Journal of Agricultural Education and Extension* in 2018.

Paper 1 forms the basis of the thesis by providing a systematic literature review on the previously conducted *ex-post* evaluations on PEPs. The main findings are: 1) most evaluations are quantitative by applying (quasi-) experimental research designs; 2) about 30% of the quasi-experimental research designs did not correctly account for endogeneity or selection bias; 3) most evaluations were only planned after programme implementation, which for example complicates obtaining a robust counterfactual; 4) a low number of evaluations included environmental impact outcomes; and 5) most evaluations were conducted on programmes in

developing countries. These literature gaps are used as the basis for further research in the thesis.

1.5.2 Paper 2

The evaluation of a participatory extension programme focused on climate friendly farming. The paper has been published in the *Journal of Rural Studies* in May 2020.

This paper conducted an *ex-post* evaluation of a PEP in Scotland, focused on the voluntary uptake of on-farm climate friendly farming practices. The study found that PEP participants show higher levels of practice adoption compared to non-PEP participants. However, the qualitative part of the evaluation showed that PEP participants themselves do not attribute this higher level of practice adoption to PEP participation. Another interesting finding was that a higher level of practice adoption is observed in the group that has recently participated in the PEP, while participants that participated in 2010-2013 do not show such a high level of practice adoption anymore compared to the control group.

The paper builds on literature gap 1 identified in Paper 1 by conducting a mixed methods evaluation, in which both qualitative and quantitative methods are used to assess the effectiveness of a PEP. Furthermore, it addresses gap 2 by using the propensity score method to correctly account for endogeneity and selection bias. Moreover, it addresses gap 4 by including environmental outcomes in the quantitative evaluation. Lastly, a case study in a developed country has been selected to address gap 5. The difference in programme effectiveness between farmers participating in the PEP between 2014-2017 and farmers participating between 2010-2013, led to the question whether these type of PEPs lead to long term sustained change. This was formulated as a 6th gap: Do PEPs stimulate the embedding of climate-friendly practices in the culture of farming? This gap is addressed in Paper 4.

1.5.3 Paper 3

Policy and practice certainty for effective uptake of diffuse pollution practices in a light touch regulated country. The paper has been published in *Environmental Management* in December 2019.

This paper builds on findings from 52 semi-structured interviews and 9 field days and meetings with farmers in New Zealand to identify factors that influence farmer decision-making regarding the voluntary uptake of water quality practices. Although certainty around policy and practice effectiveness were two decision-making factors of high importance to all farmers, there was a large heterogeneity shown in the importance of other factors. This heterogeneity was used to develop a farmer typology. The typology showed that to optimise extension design, the types of farmers in a target area should be identified and knowledge on these types should be used to apply the right modes of extension, such as neighbour mimicry. The study highlights more research is required into how information spreads through farmer networks, to again optimise programme design before implementation. By taking an explanatory view on evaluation and conducting the study in a developed country, it addresses gap 3 and 5 identified in the literature review.

1.5.4 Paper 4

Reshaping the culture of farming through participatory extension: An institutional logics perspective. The paper has been submitted to *Land Use Policy* in November 2019 and based on the editor's suggestion transferred to the *Journal of Rural Studies* in December 2019, where it is currently in the second round of revision.

Paper 4 analyses 72 interviews conducted in Scotland and New Zealand. It examines the effects of societal pressure, which demands a shift from a farming culture of maximising food production and maintaining the family business towards a culture of prioritising environmentally friendly management practices. This demand is creating a clash within the culture of farming. The study uses institutional theory to explore the clash and how this changes farmer's practices, beliefs and values. Furthermore, it looks at which mechanisms PEPs can apply to support farmers facing this clash.

The paper addresses gap 1, 5, and 6. The paper addresses gap 1 by showing the value of a qualitative *ex-post* evaluation by measuring the change in not only practices, but also beliefs and values, which are required if sustained change is to occur. Gap 5 is addressed by studying PEPs in two developed countries: Scotland and New Zealand. Lastly, gap 6 is addressed by evaluating

the potential for sustained change by not only focusing on practice adoption, but also on the beliefs and values shaping farming culture in Scotland and New Zealand.

1.6 Data collection method for submitted journal papers

To increase understanding into how the data was collected for all papers, this section briefly outlines what data collection method was applied for each of the papers. Figure 3 provides an overview of the data used for each of the papers. Paper 1 is not included in the data collection overview, because this paper is a literature review and informed by scientific peer reviewed literature.

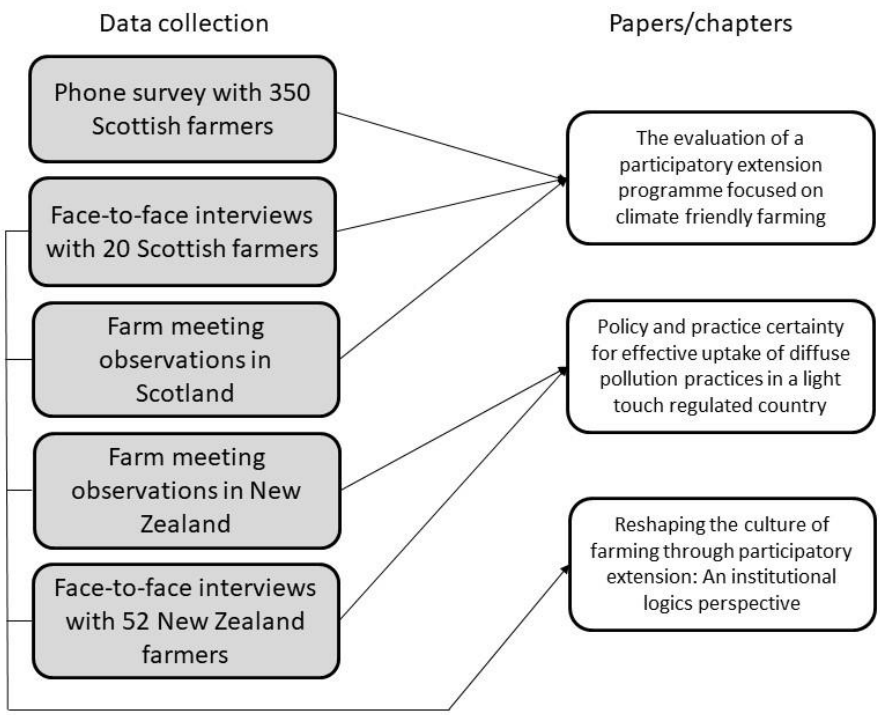

Figure 3. Overview of how the data collected in this study informed each output (paper/chapter) of the thesis.

The data collection for Paper 2 (Chapter 3) consisted of a phone survey with 350 farmers, conducted in November-December 2017, 20 face-to-face interviews in October-November 2018, and farm observations in May-June 2017. The survey contained a set of closed questions, which had partially been informed by farm visits, i.e. the farm visits had increased understanding into the agricultural sector in Scotland and thereby helped in assuring the questions resonated with the on-farm activities. The survey included a question to identify which farmers would be

interested in participation in a follow-up interview. This allowed me to, in October-November 2019, contact 20 farmers for face-to-face interviews to increase understanding into social learning due to PEP participation. Part 1, demographic questions, and part 2, questions on social learning and management skills, were used for Paper 2.

The data collection for Paper 3 (Chapter 4) consisted of farm observations in February-March 2018 and face-to-face interviews in March, April and May 2018. Part 1, demographic questions, and part 2, questions on farmer decision-making, were used for Paper 3.

The data collection for Paper 4 (Chapter 5) mainly consisted of face-to-face interviews. These were the same interviews conducted for data collection of Paper 2 and 3, but a different part of the interviews was used for data analysis of this paper. After conducting the survey of Paper 2, gap 6 (lack of measuring sustained behavioural change) was identified. Due to the temporal gap of three months between the survey of Paper 2 and the face-to-face interviews of Paper 2 and 3, there was the option to include a section to identify sustained change. Therefore, data on behavioural change was also collected during the face-to-face interviews and subsequently analysed to inform Paper 4.

2. Paper 1: Evaluation of farmer participatory extension programmes

2.1 Abstract

Purpose: Participatory extension programmes are widely used to promote change in the agricultural sector, and an important question is how best to measure the effectiveness of such programmes after implementation. This study seeks to understand the current state of practice through a review of *ex post* evaluations of participatory extension programmes.

Design/Methodology/Approach: A systematic literature review of the peer reviewed literature was undertaken to analyse the evaluations based on: i) year of publication; ii) location of the study; iii) programme delivery; iv) evaluation methods; v) outcome variables; and vi) inclusion of evaluation in initial programme design.

Findings: The review finds that almost all studies use an experimental or quasi-experimental research design (i.e. using a control group or counterfactual), but some studies do not account for endogeneity or selection bias. Furthermore, only a small number of the evaluations were planned as part of the original programme design, which causes difficulties in obtaining robust counterfactuals. The review also finds that relatively few evaluations, approximately 20 percent, measure the programme impact on environmental outcomes and only 15 percent of the evaluations have been undertaken for programmes in developed countries.

Practical implication: Limitations with current evaluation practice are identified, and recommendations are provided for improving practice, including better treatment of endogeneity, and the complementary use of qualitative data.

Theoretical implication: The review provides a contribution to the debate about the use of quantitative versus qualitative evaluation methods, by addressing the use of both quantitative and qualitative evaluation methods in a complementary way.

Originality/Value: Despite their widespread implementation, this is the first systematic literature review for published evaluations of participatory extension programmes in the agricultural sector.

Keywords: impact evaluation, voluntary uptake, extension programme, agriculture, ex post evaluation, discussion groups

2.2 Introduction

Extension activities are widely applied to stimulate change in the agricultural sector (Black, 2000). For many years, extension was based on the linear top-down transfer of technology, in which technology was developed and validated by researchers, communicated by extension agents and adopted by farmers (Black, 2000). However, since the 1980s this approach has been subjected to various critiques, such as failing to account for the context and complexity of the agricultural sector (Pretty and Chambers, 1993), which in turn decreases the adoption of technology. Therefore, an alternative extension approach has been developed in which farmers play a more central or 'participatory' role in the acquisition of knowledge and change of practice (Cristóvão et al., 2012; Scoones and Thompson, 2009). In these 'participatory' extension programmes (PEPs) researchers and extension agents fulfil a facilitating role, while farmers actively set the agenda and engage with their peers (Black, 2000).

Given the public investment in PEPs, and the increasing requirement for accountability by policy-makers and funding bodies, it is important that these programmes are reliably evaluated (Faure et al., 2012; Klerkx et al., 2016). However, evaluating PEPs might present new challenges, as PEPs may require a different evaluation approach than the evaluation of top-down extension programmes. The evaluation of top down programmes is mostly focused on programme outcomes, but it is questioned whether this approach sufficiently addresses the main aim of PEPs, which is to include farmers in agenda-setting and collective learning (Murray, 2000). Therefore, it is interesting to identify the current state of evaluation practice and identify recommendations for improvement.

To identify the current state of practice, this study provides a systematic review of peer reviewed evaluations for PEPs . Although previous reviews overlap this topic, e.g. reviews focused on Farmer Field Schools (Davis, 2006; Van den Berg, 2004; Van Den Berg and Jiggins, 2007), or evaluations of all types of extension programmes (World Bank, 2011), this review is the first – to the authors' knowledge – to focus specifically on PEP evaluations. The contribution lies in the identification of best practice for *ex post* evaluation methods, derived from the peer reviewed literature for agricultural PEPs. Ultimately, the review identifies limitations within the currently

applied evaluation methods and provides recommendations for future evaluations. The remainder of this paper proceeds as follows: The next section describes the systematic review method; followed by a presentation and discussion of the findings from the review; and the paper concludes with a number of recommendations.

2.3 Methods

2.3.1 Definition and scope

PEPs are programmes in which farmers interact with peers and experts, where experts fulfil a facilitating role and farmers actively participate in goal and agenda setting. Programme meetings take place over a period of time and create knowledge by participatory learning methods, such as group or one-on-one meetings, training sessions and (experimental) demonstrations (Black, 2000). The intended outcomes from PEPs include changing farm practices, enhancing social learning, increasing resilience to challenges and uncertainties, and sharpening farmers' management skills and decision-making abilities (Cristóvão et al., 2012).

This systematic review focuses on peer reviewed studies that measure the effect of PEPs *ex post*, that is, after the implementation. Although there are evaluation studies reported in the grey literature, i.e. the sources of literature outside of traditional academic publications, such as theses, reports from governments or organisations, and working papers, these are not included in the review, because the main aim is to identify best practice for evaluation from a scientific perspective.

2.3.2 Sources of information

An initial inventory of peer reviewed publications on the evaluation of PEPs was conducted including studies until August 2017, by using the electronic databases of ISI Web of Knowledge (www.isiknowledge.com) and Google Scholar (scholar.google.com). We used the following key words, either alone or in combination: 'agriculture', 'evaluation', 'participatory extension programme', 'voluntary advisory programme', 'policy', intervention', 'impact' and 'assessment'.

This initial search resulted in 45 publications. To provide a more exhaustive list of evaluations we conducted a second search in the previously mentioned electronic databases including studies until December 2017, by using additional search terms often associated with PEPs (Black, 2000; Braun, 2006; Cristóvão et al., 2012): 'participatory learning and action', 'participatory technology development', 'facilitation of local processes', 'local development', 'agro-ecological extension', 'farmer field schools', 'farmer first', 'farmer-led extension', 'farmer networks', 'study circles', 'farming systems research and extension', 'farmer study groups', 'rural resource center', 'farmer to farmer training', 'master farmer training', 'local learning groups', 'participatory advisory programme', and 'discussion groups'. This yielded an additional 26 studies, bringing the total to 71. This expanded set of key words may still not provide an exhaustive list, but address the main studies in this field.

To focus on recently conducted studies which evaluate the effect of PEPs, we only included publications which: i) focus on the effect after implementation of the PEPs, also referred to as *ex post* evaluations; ii) present the effect of the PEP using empirical findings; iii) focus on PEPs within the agricultural sector; and iv) have been published in or after the year 2000. The search resulted in 71 studies, which we further analysed based on six aspects. Firstly, the year of publication was used to identify a trend in the number of evaluations over time. Secondly, the location of programme was identified to analyse the spatial distribution of the PEPs evaluated. Thirdly, the type of delivery was analysed, to find similarities in programme design. There are for instance a number of studies that apply the farmer field school approach, which is a uniform programme design applied in many developing countries. Fourthly, evaluation methods were categorised to identify the types of method and their frequency of use. Fifthly, the outcome variables used in the evaluation studies were identified, e.g. economic outcome variables, environmental outcome variables etc. Finally, we identified whether the evaluation studies were built into the initial programme design. In the absence of any explicit mention of an evaluation in initial programme design, the presence of a baseline survey was taken as an indicator of evaluation planning.

2.4 Findings and discussion

2.4.1 General findings

A total of 71 published evaluation studies for PEPs were identified, from 42 different journals. A general finding in relation to terminology is that 'impact assessment', 'effect' or 'effectiveness' are used interchangeably to indicate some form of quantitative evaluation. 68 out of 71 studies found a positive difference after the intervention, the exceptions being Feder et al. (2004a, 2004b) and Rejesus (2012). It is possible that there are additional, unpublished, evaluations that do not show a positive effect on the participants, but these may not have been published in the scientific literature due to publication bias, i.e. editors, funders, reviewers and researchers have a preference for studies that show a statistically significant effect (Duflo et al., 2007).

Appendix A.1 provides an overview of the collected studies that will be discussed in terms of the six aspects previously mentioned.

2.4.2 Year, location and type of delivery

Only eight publications were found that conducted an evaluation between 2000 and 2006, indicating an increase in evaluations over the last decade (Fig. 4). An overview of the studies categorised per continent is depicted in Fig. 5. Analysis of the location of the studies shows that the majority of the studies have been conducted in countries in Africa and Asia. Further analysis shows that 62 of the 71 studies were conducted in developing countries (as classified by the United Nations (2018)), which can be explained by the fact that the majority of PEPs are implemented in the developing world (Anderson and Feder, 2004). A popular type of PEP in developing countries are Farmer Field Schools (FFS), which use education to strengthen farmers' capacity to what can be considered as 'best practices'. Typically, FFSs consist of 20-25 farmers who, under guidance of a trained facilitator, meet on a weekly basis for a predefined period to discuss environmental topics, such as soil fertility and pest management, but also other topics, such as the development of marketing skills (FAO, 2017). 48 out of the 62 developing country studies focused on the evaluation of these FFSs. The other 14 evaluations were applied to a wide

range of PEPs. For instance Pamuk et al. (2015, 2014) studied 'participatory innovation platforms', in which local stakeholders meet and collectively identify problems and solutions; Kraaijvanger et al. (2016) studied 'participatory experimentation programmes', in which farmer groups participate in learning cycles consisting of experience, design, experimentation and reflection; and Schreinemachers et al. (2016) looked at 'farmer training', which refers to participatory training of farmers during a two day workshop, followed by regular farm visits by experts and peers.

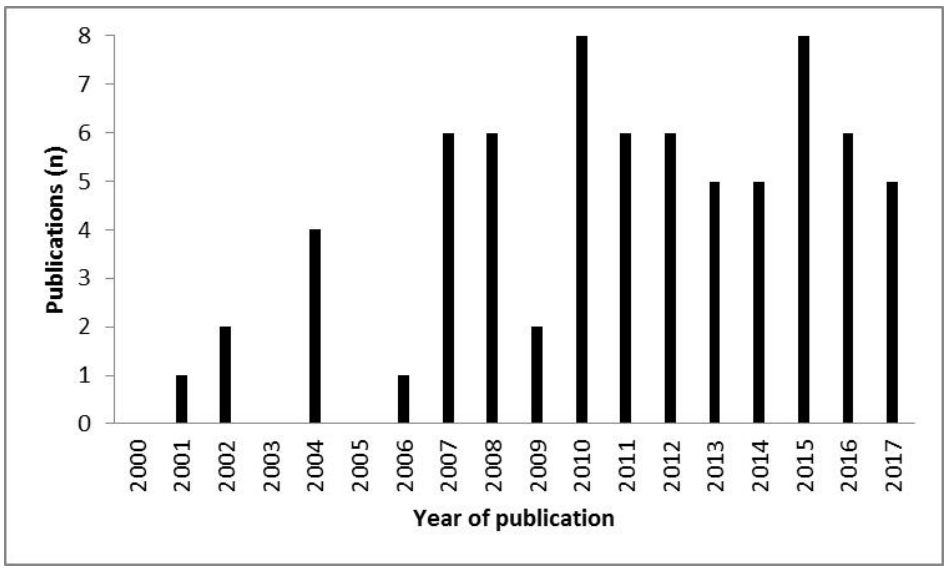

Figure 4. *Ex-post* evaluations of participatory extension programmes categorised by the year of publication.

FFSs tend not to be applied in developed countries, although the PEPs used in developed countries show similarities in programme delivery, such as the inclusion of education and group activities. A total of nine evaluation studies were conducted in developed countries: Bruges & Smith (2008) examined the effect of farmer participatory research groups regarding the adoption of sustainable practices in New Zealand; Hill et al. (2017) focused on the programme 'Farming Connect' in Wales, which aims to promote knowledge transfer, advice and training for farms and forestry holdings; Hennessy & Heanue (2012), Läpple & Hennessy (2015) and Läpple et al. (2013) looked at the effectiveness of discussion groups in the dairy sector in Ireland; Prager and Creaney (2017) evaluated how discussion groups in Ireland and monitor farms in Scotland work and which factors influence their success; King et al. (2008) considered whether participatory action

learning, a participatory extension approach for farmer groups, increases learning compared to more traditional extension approaches in Australia; Roche et al. (2015) evaluated a participatory-based experimental learning programme in which experts work with focus farms to change dairy producer behaviour to control Johne's disease; and Tamini et al. (2011) evaluated the uptake of best management practices after participation in farmer advisory clubs in Canada.

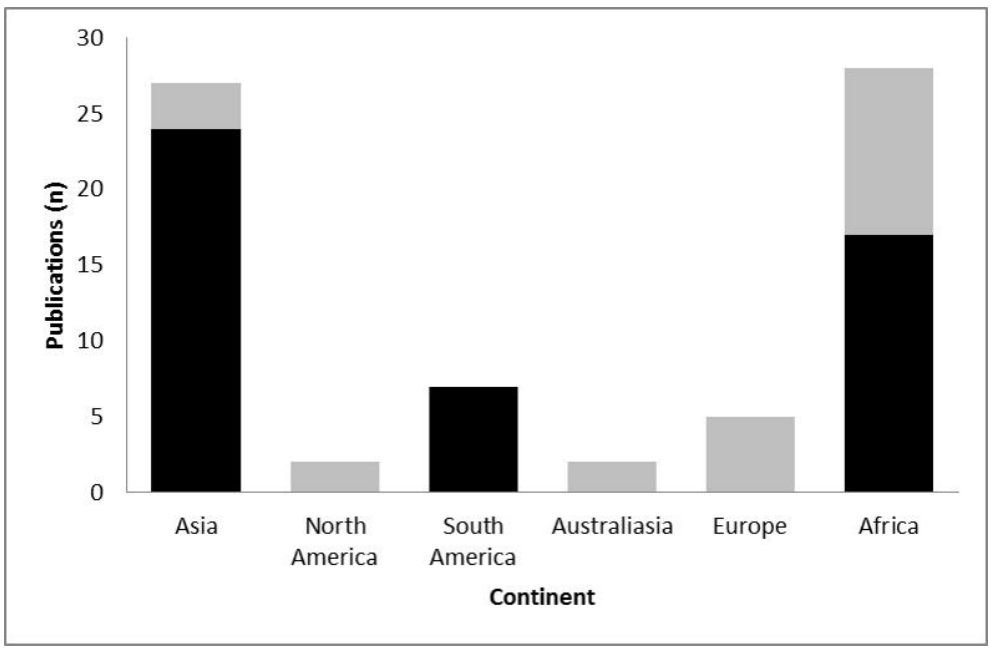

Figure 5. *Ex-post* evaluations of participatory extension programmes categorised by continent. The share of studies evaluating a FFS is indicated in black and the share of studies in which a different type of PEP is evaluated is indicated in grey.

2.4.3 Evaluation methods

The different evaluation methods found within the published studies of PEPs are analysed using the categories presented in Fig.6. This categorisation first divides the evaluation methods according to whether they are quantitative, qualitative, or mixed methods, with the quantitative methods further subdivided according to their treatment of endogeneity.

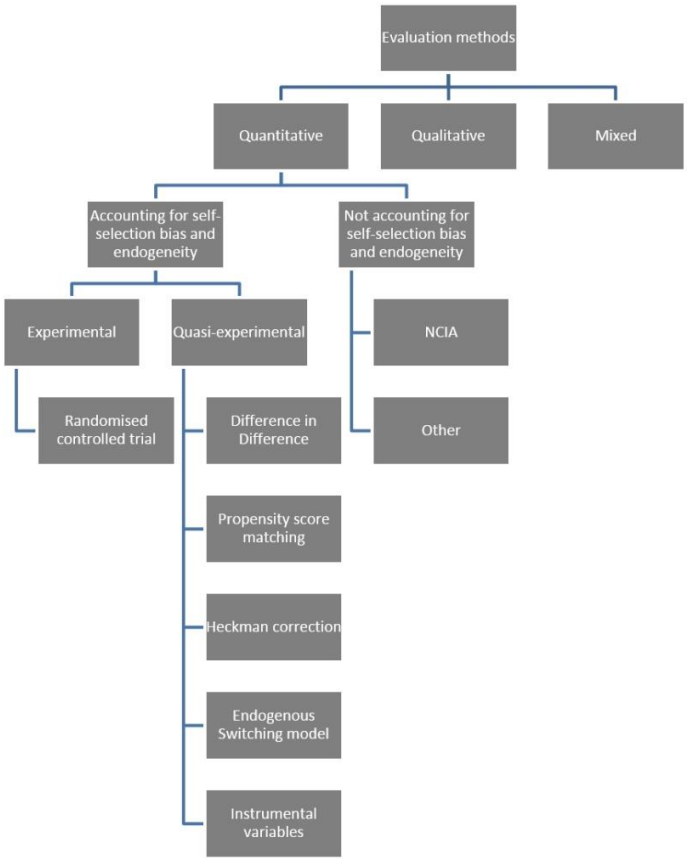

Figure 6. A categorisation of the evaluation methods used to conduct an *ex-post* evaluate of PEPs.

2.4.3.1 Quantitative methods

64 of the 71 identified studies evaluated the PEP by (mainly) applying a quantitative method. These studies were further classified (according to the categorisation in Fig.6) on the use of 1. a method accounting for self-selection bias and endogeneity, including experimental, quasi-experimental and other approaches, or 2. a method not accounting for self-selection bias and endogeneity. An overview of the quantitative methods applied is provided in Fig.6.

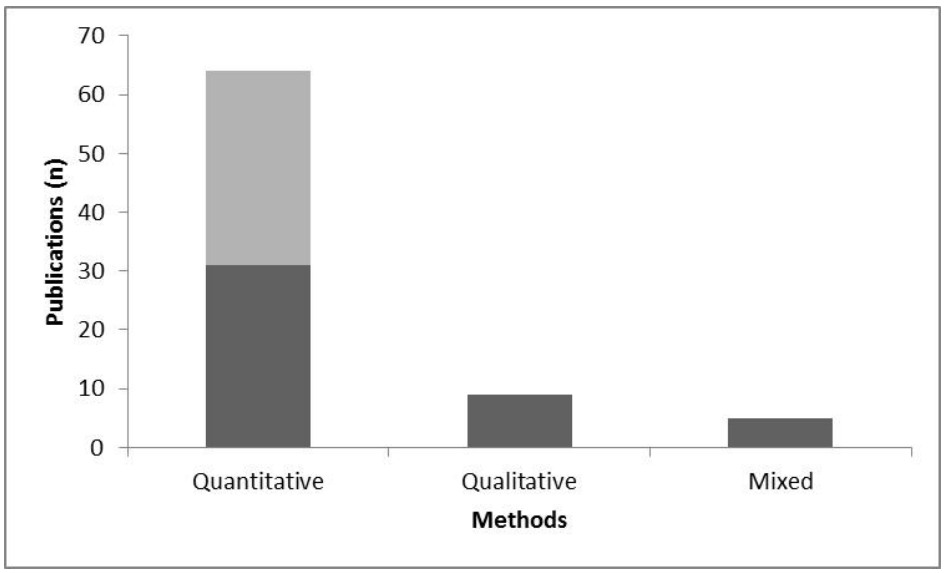

Figure 7. *Ex-post* evaluations of participatory extension programmes categorised by quantitative, qualitative and mixed methods. The number of methods included in the figure (78) is higher than the number of evaluation studies (71), because some studies applied multiple methods and were therefore classified in more than one category. The share of studies that correctly account for selection bias is depicted in black, while the share of studies not accounting for selection bias is depicted in grey.

Accounting for self-selection bias and endogeneity. 32 studies used an experimental or quasi-experimental research design to conduct a quantitative evaluation, hereafter also referred to as 'impact evaluation', which is a widely used term in literature and addresses the effectiveness of a PEP by comparing it to the situation in the absence of the PEP (Gertler et al., 2016) and only one study used a different approach.

Experimental research design. Experimental research designs allocate participants randomly to a treatment or control group to prevent selection bias, which arises when participants and non-participants differ in characteristics that are related to participation in the programme and to the outcome (Duflo et al., 2007). Random allocation of participants is assumed to correct for any imbalance in characteristics, and the groups only differ in the presence or absence of the treatment. The effect or impact of the treatment can therefore be estimated as the difference between the control group and treatment group (Duflo et al., 2007; Duflo and Kremer, 2003).

Within the evaluation methods identified, the randomised controlled trial (RCT) is the only purely experimental method, and was only used in one of the studies: Guo et al. (2015) randomly selected treatment villages for participation in the programme in question. Although RCT optimally accounts for selection bias, the application is complicated and this is most likely the reason for the limited use of the method. The methodological challenges include: the need to plan the evaluation during the initial stages of PEP implementation; overcoming ethical restrictions which may arise when non-participants are disadvantaged because of exclusion from the treatment group; accounting for spill-over effects that can occur when participants exchange information with non-participants (Duflo et al., 2007). As an illustration of the difficulties with this method, Guo et al. (2015) found that the treatment villages in their study did not show a high level of comparability with the control villages, and to avoid imbalance between the treatment and control groups they applied matching techniques (see below) to account for the differences.

Quasi-experimental design. In contrast to experimental research design, quasi-experimental approaches allow non-randomised selection or self-selection of the treatment group, e.g. prospective participants can volunteer for the treatment group. Any endogeneity and self-selection bias can then be accounted for using one of several techniques: i) difference-in-differences (DiD); ii) propensity score matching (PSM); iii) the Heckman correction (HC); or iv) endogenous switching model (ESM).

The review found that difference-in-differences (DiD) was the most commonly used method, with 14 studies using this approach. This method compares the before and after changes of a treatment group with the before and after changes of a control group, thereby controlling for differences in unobservable characteristics. The approach quantifies the difference between the groups in two steps: i) it quantifies the average difference in outcome for the treatment and control group; and ii) it calculates the average difference between the average changes for the treatment and control group (Bertrand et al., 2004). An example of a study which applied DiD is Mancini et al. (2008), which measured the before and after effect of FFSs in India. An RCT was not possible because although the programme targeted specific villages, farmers' participation was on a voluntary basis. Therefore, DiD was used to account for seasonal or systematic effects

other than the training effect, such as socio-economic factors, which might have favoured the participation of more progressive, wealthier and educated farmers. Togbé et al. (2014) also applied DiD to account for the non-randomised selection of farmers participating in the FFS. In Rejesus et al. (2012) the DiD approach was used to account for differences in village characteristics, because villages were selected to participate in the FFS based on access to the village, and the presence of active farmer groups.

Five studies applied propensity score matching (PSM), which addresses endogeneity and self-selection bias by creating a propensity score for each participant based on socio-economic and other relevant characteristics, and then matches scores between members of the treatment and control groups to create groups that are as closely matched as possible (Stuart, 2010). This method is useful when baseline data and longitudinal observations are lacking (and therefore the DiD method cannot be applied), but abundant cross-sectional data for participants are available. However, a crucial assumption and potential weakness of the PSM method is that there are no unobservable characteristics that may cause a difference in results between the treatment and control group. Examples of the application of PSM can be found in Godtland et al. (2004), which applies PSM to evaluate the effect of FFSs (on knowledge of integrated pest management) with cross-sectional data, and in Schreinemachers et al. (2016), which uses PSM to quantify the effect of farmer training.

Five studies applied both PSM and DiD (Benin et al., 2011; Davis et al., 2012; Kangmennaang et al., 2017; Rodriguez et al., 2007; Todo and Takahashi, 2013) to account for systematic differences between participant and non-participant outcomes, which may continue to exist even after matching observable characteristics (Heckman et al., 1997). These differences may for example occur due to programme selection based on unmeasured characteristics, or because the treatment and control groups reside in different regions. Although combining PSM and DiD has the advantage of controlling for both observable and unobservable characteristics, it requires an extensive dataset.

One study applied the Heckman correction (HC) to account for endogenous effects (Rejesus et al., 2009); one applied an endogenous switching model (ESM) (Läpple et al., 2013); and five

studies applied instrumental variables (IV) (e.g. Tamini, 2011; Wafula et al., 2016). All three methods require an instrument or exogenous variable, i.e. a variable that is not included in the equation of interest and via which the counterfactual can be established. However, in many situations there is no obvious or measurable exogenous variable, which complicates the application of this method.

Not accounting for self-selection bias and endogeneity. In addition to the studies above, 32 studies calculated the effect of PEPs by conducting an impact evaluation, but did not account for endogeneity or self-selection bias either explicitly or correctly. We have categorised these studies into 'No correct impact evaluation (NCIA)' and 'Other methods'.

NCIA. Although the NCIA studies show positive results, the reliability of the findings is questionable. For instance Tin et al. (2010) conducted a baseline and an *ex-post* survey to measure change over time. However, they did not include a control group to properly account for unobservable characteristics. Furthermore, Läpple et al. (2013) provide a critique of Hennessy and Heanue's (2012) PEP evaluation, noting that a major limitation is the neglect of self-selection bias and endogeneity. This causes the under- or over-estimation of programme effects, weakening the policy relevance of this work (Läpple et al., 2013). Other studies such as Bentley et al. (2007) do not mention self-selection or endogeneity at all.

Other quantitative methods. One study applied a different quantitative methodology to assess the effect of a PEP. Bourne et al. (2017) assessed the performance of participatory advisory programmes by using social network analysis (SNA), which is the process of investigating social structures through the use of networks, as a tool to examine farmer networks. The study used SNA to analyse whether farmer networks change due to participation in an advisory programme. More specifically, it assessed the contribution towards joint decision-making, cooperation in the implementation of innovations and management of collective activities. Although the study presents a new framework to assess the PEP on these outcomes, it does not address the change in information over time, or compares the findings with a control group. Hence, we argue that in the application of this method a valid counterfactual is lacking, which undermines the findings of this study.

The absence of a reliable method to account for endogeneity in 32 published studies is a striking finding from this review, and should be noted by journal editors and reviewers, as well as researchers undertaking evaluation studies.

2.4.3.2 Qualitative evaluation methods

We identified seven qualitative studies focused on PEP evaluation. This number appears low and we suspect that some qualitative studies are potentially disguised behind atypical titles and therefore are more difficult to detect by keyword search. King et al. (2008) is an example of a qualitative study, which applied the convergent interviewing approach, seeking to reveal participants' reported experience of effective learning. The study observed a positive effect and argues 'soft' evaluation techniques such as convergent interviewing are a successful tool when faced with 'difficult to measure' PEP effects. Furthermore, Prager & Creaney (2017) combine qualitative interviews, participant observation and document analysis to draw conclusions about how participatory groups work and what influences their success.

2.4.3.3 Mixed evaluation methods

Five studies mentioned the application of both a quantitative and qualitative method. All these studies applied a qualitative method in addition to an impact assessment to measure the effect of a PEP and are thus partially already discussed in the previous sections. For instance David and Asamoah (2011) conducted focus groups prior to the impact assessment to increase understanding of farmers' perceptions of the impact of the FFS. They specifically asked for the impact on knowledge, decision-making skills, experimentation and knowledge diffusion, which helped in identifying suitable indicators for the impact assessment. Dolly (2009) aimed to assess 14 FFSs in Trinidad & Tobago in relation to six key extension challenges. Besides conducting interviews with individuals from the treatment and control groups, they also attended FFS meetings and included the observations during the meetings in the interpretation of the interview findings.

Not all studies explain the use of additional qualitative methods. For example, the methodology section of Davis et al. (2012) refers to qualitative data obtained from document analysis and semi-structured interviews, but omits a transparent description of how the qualitative data is included in the study, and the results section only presents an analysis of the quantitative data. Similarly, Lund et al. (2013) undertook interviews to gain insight into the views of participants on the programme and how knowledge was acquired through programme participation. However, again only results from quantitative data analysis are presented.

Hill et al. (2017) also applied both quantitative and qualitative methods. The study included qualitative interviews with farmers to gather data on the farmers' own perceptions of the effectiveness of the PEP in question. The findings were then compared to the results from a quasi-experimental impact assessment. This showed that the qualitative approach finds a more positive outcome than the quantitative approach, which may be explained by interviewer bias and overly positive reporting in the qualitative interviews. Arguably the use of a qualitative method for impact assessment and the subsequent comparison with a quantitative method is not a fair approach as the appropriate use of qualitative methods should be to provide a more in-depth and nuanced understanding of participant motivations and perceptions (rather than being an alternative to quantitative impact evaluation). Kraaijvanger et al. (2016) used quantitative and qualitative methods to complement each other. To gain insight into which changes farmers made and whether the programme was responsible for these changes, data were collected via interviews and observations, which in turn provided detailed insight in the functioning of the programme. Overall, several studies argue that in the evaluation of participatory programmes qualitative and quantitative methods should be used to complement each other (Munro, 2014; Murray, 2000).

2.4.4 Outcome variables

As mentioned in the methods section, PEPs aim to change farm practices, enhance social learning, increase resilience to challenges and uncertainties, and sharpen farmers' management skills and decision-making abilities. We firstly found that although there is no reason to assume one aim is more important than another, the majority of the studies, with exception of Duveskog

et al. (2011) and Jones et al. (2014), include outcome variables related to the first aim: the change in farm practices. Across the 69 studies that included outcome variables related to practice change, 23 different evaluation outcome variables were identified, as shown in Appendix A.1. The most common variable was 'knowledge acquisition', followed by 'financial performance'. In a sense, the 'knowledge acquisition' and also the 'knowledge diffusion' variables are of a different order to the other outcome variables, as they may subsume or include any of the other categories, i.e. the knowledge acquired may relate to financial management, productivity, food security etc. Furthermore, in some evaluations, e.g. Tin et al. (2010), only knowledge acquisition is used as an indicator, because in this study it is assumed that increased knowledge translates into a change of farming practice. Although David & Asamoah (2011) also use knowledge acquisition as a single indicator, they recognise that practice change does not only depend on knowledge, but other factors as well, such as economic conditions. This point, i.e. that knowledge acquisition does not entail impact, is widely recognised within the literature on agricultural innovation (Meijer et al., 2015; Rogers, 2003). In order to address this issue the majority of studies using knowledge acquisition as an indicator combine it with indicators measuring the actual change in practice (e.g. Erbaugh et al., 2010; Godtland et al., 2004; Mutandwa and Mpangwa, 2004).

A second notable finding is that few evaluation studies focused on environmental outcomes, with only one considering ecological footprints, ten considering pesticide use, and one focusing on practice change in relation to climate change. Although this is likely to largely reflect the focus of the PEPs themselves, it nevertheless indicates that there is relatively limited research experience in evaluating the effectiveness of PEPs on environmental outcome indicators.

Thirdly, it should be noted that although most PEPs evaluated are FFSs, and FFSs have a largely uniform programme design, there is no standard set of indicators applied to their evaluation. Simpson & Owen (2002) address this issue by highlighting six key issues around FFSs in Africa: relevance and response to local concerns, knowledge acquisition, knowledge diffusion, local institutionalisation and organisational development, impact on relationships, and FFS integration into existing programmes. They argue that in addition to outcome variables extra attention should be paid to these six aspects to evaluate the effectiveness of FFS programmes. Only one

evaluation assessed an FFS on all these six aspects (Dolly, 2009), but in 22 FFS studies knowledge diffusion and acquisition are used as outcome variables, which indicates the partial use of the six indicators proposed by Simpson & Owen (2002).

2.4.5 Inclusion of evaluation in initial programme design

The final aspect of the systematic review identified whether evaluation was built into the initial PEP design, i.e. whether data collection and the evaluation method were planned prior to programme implementation. The reason for including this aspect in the review is that such planning is a key determinant of the type and robustness of the *ex post* evaluation that can be subsequently undertaken (Baslé, 2006).

The studies that applied either an RCT or DiD method were usually planned as part of the PEP design, because both methods require data collection before and during the programme. However, although Larsen and Lilleør (2014) applied the DiD method, they mention the absence of a detailed evaluation plan at the beginning of their data collection. They evaluate a programme that was phased-in at different villages, and so although only cross-sectional data were available for the first phase, it was possible to gather baseline data for the second phase. In addition, although the evaluation commenced after the start of the PEP, the authors sought to avoid *ex post* bias, the cherry-picking of suitable indicators later, by basing the evaluation on previously stated aims. Davis et al. (2012) and Feder et al. (2004a) also provide a potentially useful approach for undertaking a DiD method in the absence of complete baseline data. Their baseline survey did not contain all the data required to compute the impact of the PEP, and therefore they used recall data from farmers to fill the data gaps for the situation before the implementation of the programme. Moreover, Jors et al. (2016) did not have access to a complete longitudinal dataset either, because longitudinal data were only available for FFS and exposed farmers, but not for a control group. Therefore, DiD was only applied to make a comparison between FFS and neighbouring farmers and cross sectional data were used to assess the programme compared to the control group.

The studies that used a cross-sectional dataset did not have the evaluation built in. For example Godtland et al. (2004) and Läpple & Hennessy (2015) explicitly mention the limitation in choice of evaluation methods due to the lack of baseline data.

2.5 Conclusion and recommendations

Given the level of investment and expectation of positive outcomes from PEPs, it is important that these PEPs are properly evaluated. To identify and develop best practice this study provides a systematic review of published evaluations in this area. Based on the findings from the review, we offer several recommendations for improving evaluation practice.

Firstly, we would like to address the large amount of studies basing the evaluation of PEPs on practice change. As mentioned in the methods section, PEPs aim to change farm practices, enhance social learning, increase resilience to challenges and uncertainties, and sharpen farmers' management skills and decision-making abilities. We find that evaluation studies mainly address the first aim: change in farm practices. We recommend the inclusion of the other aims as well, to provide a more holistic evaluation of the PEP.

Secondly, when conducting a quantitative evaluation, practitioners should select methods that address endogeneity and selection bias, as failure to do so undermines the reliability of the evaluation results due to under- or over-estimation of programme effects. Equally, agencies commissioning evaluations, as well as journal editors and reviewers, should request such methods to be used.

Thirdly, although a number of existing studies used some form of qualitative method alongside a quantitative method, the use of qualitative data was not well integrated, or was treated as an alternative to quantitative methods. We recommend that qualitative data should be used to complement quantitative assessments, in order to provide additional insights into the perceptions and motivations of participants, the barriers they face, and the context in which programmes are implemented (Davies et al., 2000; Montuschi, 2014). It is particularly important

to understand the social context of a programme when trying to extract lessons from a specific study.

Fourthly, we recommend that *ex post* evaluation should be considered in the initial design of any PEP, and the policy-maker or commissioning agency should take responsibility for ensuring that this is the case. When a quantitative evaluation is not planned prior to programme implementation only cross-sectional data will be available for the evaluation, restricting the evaluation to one moment in time. This makes it difficult to account for unobservable characteristics. Hence, planned evaluations (prior to programme implementation) allow the establishment of robust counterfactuals and have a large influence on the quality of the impact assessment (Läpple et al., 2013).

Fifthly, we want to make a recommendation regarding the choice of indicators selected for evaluation. Although it is essential that *ex-post* evaluation is considered in the initial design of any PEP, this does not mean that the all the outcome indicators have to be determined by the evaluating party beforehand. In order to align with the ethos of a participatory approach, where collectively setting goals is one of the main aims, and to ensure that the evaluation findings are relevant to the on-going implementation of the programme, the participants themselves should be involved in the selection of some of the outcome indicators (Bruges and Smith, 2008; Murray, 2000).

Sixthly, we have observed multiple impact evaluations that only use 'knowledge acquisition' as an indicator to assess the effectiveness of a PEP. Although knowledge is recognised as an important factor in practice change, change is also highly dependent on other factors, such as economic performance. Therefore, to measure the effectiveness of a PEP the indicator 'knowledge acquisition' should be used in combination with other indicators in order to draw conclusions on the actual change in practice.

A final observation is that relatively few evaluations of PEPs have been conducted within a developed country context, and few measure the impact of programmes on environmental outcome variables. Given the increasing emphasis on the voluntary uptake of environmental measures in the agricultural sector (e.g. The Scottish Government, 2017), this suggests a gap in the literature that should be addressed by future evaluation studies.

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3. Paper 2: The evaluation of a participatory extension programme focused on climate friendly farming

3.1 Abstract

Agriculture is a major source of global greenhouse gas emissions and therefore effective policy interventions are required in order to mitigate these emissions. One form of intervention used within the agricultural sector is participatory extension programmes (PEPs). PEPs are advisory programmes based on voluntary participation where farmers, researchers, and rural experts collectively learn by sharing information and experiences. To evaluate the contribution of these programmes towards more climate friendly farming, this paper conducts an *ex-post* evaluation of a PEP focused on the voluntary uptake of on-farm emissions mitigation practices in the UK. We use a mixed-methods approach to understand both the adoption of new practices and a range of human-social outcomes such as enhanced social learning, increased resilience, and improved management skills. We find that participants in the PEP show a higher level of practice adoption compared to non-participants. However, the evaluation of the human-social indicators shows that the change cannot always be attributed to PEP participation. The paper contributes to the current literature by conducting one of the first evaluations on a climate change PEP in a developed country and by developing and applying an effective evaluation framework for climate change PEPs, in order to achieve an understanding of the change achieved by PEPs.

Key words: climate change, agriculture, extension programme, evaluation, mixed-methods

3.2 Introduction

Agriculture is directly and indirectly responsible for approximately 25% of global greenhouse gas (GHG) emissions (IPCC, 2014; Le Quéré et al., 2016), and there is an increasing interest in ways to manage emissions caused by farm level practices (Olander et al., 2014). Although a range of interventions and practices have been developed (Black, 2000), implementing these is complex due to the biophysical, economic and behavioural heterogeneity of farms. To date, attempts to stimulate the uptake of climate friendly practices have mainly been delivered through voluntary programmes seeking to reduce emissions while maintaining farm profits. One approach to

promoting these mitigation practices is via participatory extension programmes (PEPs), a type of advisory service, in which farmers, researchers, and rural experts collectively learn by sharing information and experiences. Besides stimulating the uptake of practices, PEPs aim to enhance social learning, increase resilience to challenges and uncertainties, and to sharpen the management skills and decision-making of farmers (Black, 2000; Cristóvão et al., 2012).

Given the public investment in PEPs, and their uncertainty around the potential contribution to achieving environmental targets, it is important that these programmes are reliably evaluated (Faure et al., 2012; Klerkx et al., 2016). EU member states have set up evaluation guidelines for their Rural Development Programmes, including recommendations on mixed-methods (European Commission, 2015, 2010). However, while a lot of these evaluations have probably been conducted within the EU, limited work has been reviewed and discussed in scientific literature. The evaluations that have been published in peer-reviewed literature have mainly been conducted in developing countries; predominantly financial and productivity indicators have been used to identify the monetary return on investment (e.g. Läpple et al., 2013; Läpple and Hennessy, 2015); only a limited set of studies have applied qualitative or mixed methods to evaluate the effectiveness of programmes (Jones et al., 2014; Prager and Creaney, 2017); and no study has evaluated agri-environmental PEPs to identify the contribution towards climate friendly farming.

To address this knowledge gap, this paper applies a mixed-methods approach to evaluate the effectiveness of an agri-environmental PEP in Scotland, focusing on environmental indicators and human-social aspects, i.e. practice adoption, social learning, resilience, and management skills. The paper adds to the current literature by conducting an evaluation on a climate change PEP in a developed country context by developing and applying an evaluation framework to gain understanding in the potential change achieved by such PEPs. In the following subsections we introduce PEPs and current literature regarding their evaluation.

3.2.1 Participatory extension programmes

PEPs first emerged as an alternative approach to the linear top-down 'transfer of technology' model in the 1960s (Braun and Duveskog, 2011; Millar, 2011; Parminter, 2011). The approach has been associated with: high rates of practice adoption; a positive impact on productivity and income; an increase in knowledge and skills; and good availability of peer support (Davis et al., 2012). PEPs aim to create an egalitarian environment in which farmers interact with peers and experts, with experts fulfilling a facilitating role, and farmers actively participating in goal and agenda setting. Meetings take place over a period of time, typically 1-3 years, and create knowledge by participatory learning methods, such as group or one-on-one meetings, training sessions and (experimental) demonstrations (Black, 2000). The intended outcomes from PEPs include practice adoption, enhanced social learning, increased resilience to challenges and uncertainties, and improved farmer management skills and decision-making abilities (Cristóvão et al., 2012). Overall, PEPs aim for cultural embeddedness of the key learnings, i.e. the ideas stimulated in the PEP become embedded within the farming culture and thus when the programme ends, farmers will continue incorporating the learnings into their farm management (Burton and Paragahawewa, 2011). The PEP aims will be discussed further in the Methods section, in which the evaluation framework is explained.

3.2.2 PEP evaluation

The majority of PEP evaluations have been conducted in developing countries (Knook et al., 2018; Van den Berg, 2004), where the focus of these programmes is often to improve knowledge on pesticide use. Some of these evaluations focus on environmental outcome variables, such as ecological footprint (Mancini et al., 2008) or pesticide use (Schreinemachers et al., 2016), but the majority of the evaluation literature to date is dominated by quantitative evaluations in which economic performance indicators are used to measure value for money, using indicators such as 'financial performance' and 'productivity' (Knook et al., 2018). Most studies show a positive return to programme participation in terms of an increase in financial performance or productivity, however, on closer inspection the calculation of returns is often questionable. Approximately 50 percent of peer reviewed evaluations do not properly account for self-selection bias, which occurs when participants have the opportunity to decide whether to

participate in a study or not, and results in a sample bias (Knook et al., 2018). Randomised controlled trials (RCTs) are the favoured approach to address this bias. However, RCTs are limited due to contextual complexity. Challenges include planning the evaluation during the initial stages of the PEP's implementation, overcoming ethical restrictions when non-participants are disadvantaged because of exclusion from the treatment group, and accounting for spillover effects if participants exchange information with non-participants (Duflo et al., 2007). Therefore, alternative quasi-experimental approaches are often applied, such as a 'Difference-in-Differences' approach, which compares the change over time between the treatment group and the control group, to account for unobservable characteristics (Rejesus et al., 2012; Togbé et al., 2014). In the absence of longitudinal data other approaches are widely used, such as endogenous switching regression models (e.g. Läpple et al., 2013); instrumental variables (e.g. Tamini, 2011); and propensity score matching (e.g. Läpple and Hennessy, 2015). The latter methodology is applied in this study and accounts for sample bias by matching participants from the control and treatment group on social, economic and biophysical characteristics (Läpple and Hennessy, 2015; Stuart, 2010).

Although PEPs are mostly evaluated using quantitative approaches, these may actually limit the questions studied (Cartwright, 2009; Munro, 2014). Using only quantitative evaluation approaches is criticised for overlooking other intended outcomes, such as enhanced social learning (Cartwright, 2009; Munro, 2014), and thus falling short of a holistic evaluation of a PEP (Knook et al., 2018; Murray, 2000). Prager & Creaney (2017) and Sewell et al. (2017) are two of few studies that go beyond adoption rates, to include a qualitative evaluation of levels of learning, knowledge and practice change, which are important indicators to provide insight into long-term behavioural change (Muro and Jeffrey, 2008). Another study, by Jones et al. (2014), applied a qualitative approach to assess how participation has empowered participants in making decisions about their own agricultural systems to gain insight in the effectiveness of the 'participatory' aspect of the programme.

There are few studies that apply both qualitative and quantitative methods. A recent example of Hill et al. (2017) applied a quasi-experimental and a 'naïve' approach, in which participants were asked to list their own sense of progress in the adoption of new practices. However, this study does not include other aspects of PEPs, such as resilience and management skills. Kraaijvanger

et al. (2016) addressed these aspects of the PEP, but their methods did not account for endogeneity issues regarding practice adoption. Holistic evaluation is likely to require a mix of qualitative and quantitative methods to provide greater depth of understanding (Davies et al., 2000; Montuschi, 2014).

This paper provides one of the only evaluations of a climate-focused PEP in scientific literature and applies an evaluation framework including mixed-methods approach in this context.

3.3 Methods

3.3.1 Case study

To evaluate the potential contribution of a PEP to climate friendly farming we selected a PEP in Scotland focused on reducing the impact of on-farm activities towards climate change. At the time the study was conducted, the UK was part of the European Union (EU) and its Common Agricultural Policy (CAP). Similar market systems make potential findings relevant for other EU and strictly regulated countries facing the implementation of agricultural climate change policy. At the time of evaluation, the PEP was the only policy in Scotland to reduce on-farm GHG emissions (The Scottish Government, 2017), which made its evaluation highly relevant.

The selected PEP was initiated in 2010 and targeted all types of farmers via three core areas of action: 1) knowledge transfer with focus farms: farms that work directly with experienced farm consultants to share and implement new practices while functioning as a platform for discussion group meetings with peers, researchers and experts; 2) social media accounts, posters at local consultancy offices and text alerts to advertise meetings and to disseminate information generated at the meetings, reaching a wider audience; and 3) discussion group meetings. Four focus farms hosted discussion groups from 2010 to 2013, and nine focus farms operated from 2014 to 2017. These focus farms were evaluated by i) conducting a carbon footprint before and after participation in the PEP; and ii) continuous interaction with experts and advisors to review farm practices and discussion group meetings. Although each discussion group meeting was thus internally evaluated for the purposes of continual improvement and for farmers to feedback about what they would like to feature in coming meetings, wider data collection relating to the meeting attendees and their implementation of measures was not a requirement of the

programme. Therefore, there was no knowledge on the potential contribution to emission reduction or on the programme experience of the discussion group farmers. To identify the potential contribution to emission reductions of discussion group meetings, our evaluation focused on core area 3: the farmers participating in the discussion group meetings.

The selected PEP targeted farm practices in five topic areas: i) using electricity and fuel efficiently, ii) developing renewable energy (RE), iii) locking carbon into the soil, iv) making the best use of nutrients, and v) optimising livestock management. The practices were promoted as 'no-cost', suggesting that they could reduce emissions while maintaining (and in some circumstances increasing) farm profits. Participation in the discussion group meetings was on a voluntary basis and as a consequence the group composition changed through time, depending on the schedule and interest of the farmers. This meant some of the farmers only attended a few meetings, which was taken into account as a limitation of the evaluation. The topic, content, timing and location of the meetings were planned based on discussions between the focus farm, the farm advisor and farmers who were part of the discussion group.

Over the course of the programme at least 800 farmers attended the discussion group meetings. To provide some context for the scale of the PEP, in total there are 37,735 farmers in Scotland (Scottish Government, 2018), including full-time and part-time farmers, of which approximately 30,000 are likely to be located in the targeted areas, meaning that circa 3% of the target farmers participated in the meetings. Although the PEP was the only policy focused on reducing on-farm GHG emissions specifically, some of the farmers in the target area were part of the Nitrate Vulnerable Zone (NVZ), designated areas requiring farmers to comply with a nutrient management plan (Scottish Government, 2019), which might lead to different soil management practices outside the influence of the PEP. However, due to the lack of geospatial data available for all farmers included in the sample, we were not able to account for this in the evaluation. Furthermore, due to the lack of baseline data collection, this was a 'retrofit' evaluation, i.e. only data collected after programme participation is used for evaluation given the lack of an initial set up of an evaluation framework.

3.3.2 Evaluation framework

We used the results from a previously conducted literature review of published PEP evaluation studies (Knook et al., 2018) to identify the characteristic aims of PEPs, which were then used as the basis for our evaluation framework. The characteristic aims of PEPs were identified as: i) *Practice adoption*; ii) *Social learning*, iii) *Resilience to challenges and uncertainties*; and iv) *Management skills and decision-making abilities*. The resulting structure of the evaluation framework is illustrated in Figure 8. Further explanation of these four characteristic aims, and the selection of indicators for each of them, is given below.

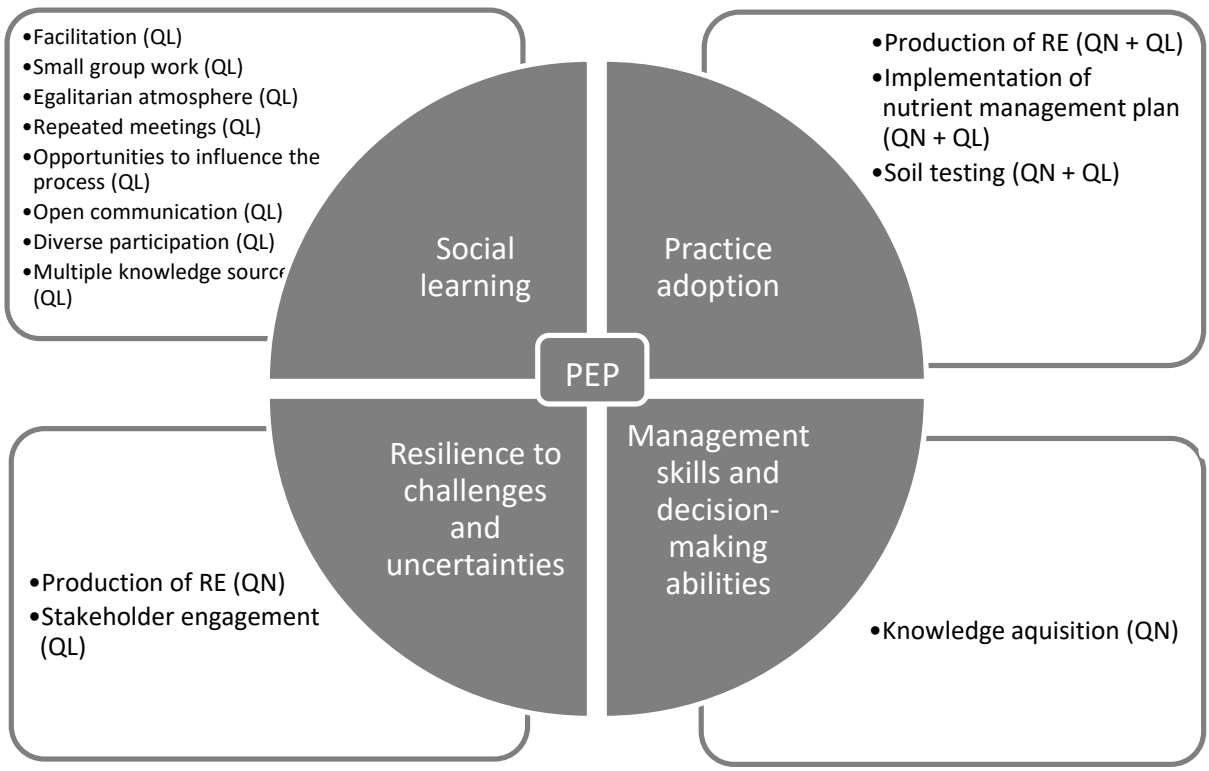

Figure 8. The framework for evaluation of participatory extension programmes. RE means renewable energy, QN refers to measuring the indicator by a quantitative approach. QL refers to measuring the indicator by a qualitative approach.

Social learning is seen as an essential component of successful participatory approaches (Muro and Jeffrey, 2008; Prager and Creaney, 2017). In the field of participatory natural resource management, social learning is generally defined as including communication and interaction of

different actors within a participatory setting, which results in social outcomes, such as knowledge generation, acquisition of technical and social skills, and the development of trust and relationships. We based the selection of indicators on the compound model proposed by Muro & Jeffrey (2008), which suggested the following indicators: i) facilitation, which indicates the level of skills of the facilitator to lead a group and build trust, and the neutrality of the facilitators' role; ii) small group work, which refers to the possibility to learn in a small group setting by being helped by experts; iii) egalitarian atmosphere, which refers to the equality of researchers, extension agents and farmers in their process of interaction; iv) repeated meetings; v) opportunities to influence the process, which includes the possibility to influence the agenda; vi) open communication between all actors, in which experiences are shared; vii) diverse participation of stakeholders; viii) multiple sources of knowledge, such as theoretical knowledge as well as practical demonstrations.

Practice adoption refers to the permanent integration of a new practice into the existing farming system. Measuring the rate of adoption was achieved by conducting a quantitative evaluation using performance indicators, which were selected based on: i) the key aims of the case study PEP; and ii) whether they were measurable amongst all of the survey respondents. The indicators selected were: RE generation (renewable heat and electricity); nutrient management plan implementation; and soil testing.

Insight into the third aspect of a PEP, *Management skills and decision-making abilities*, was obtained by measuring the cognitive and intellectual skills of the farmer using a knowledge test (Rougoor et al., 1998). Such tests have been widely applied in other studies (Feder et al., 2004b; Khan et al., 2005; Mancini et al., 2007; Rejesus et al., 2012), and consisted of six questions about using electricity and fuel efficiently and locking carbon into the soil, which were both part of the five topic areas targeted by the PEP. The test indicated whether PEP farmers are more aware of the measures they can implement to mitigate the effects of climate change compared to non-participating farmers.

Resilience is defined as the capacity of a system to cope with stress, overcome adversity, or adapt positively to change (Meuwissen, 2018). At the farm level, resilience can be measured by: i) robustness, which refers to the ability to maintain a similar level of outputs when faced with

perturbations (Urruty et al., 2016); ii) adaptability, which is the capacity of actors to adjust responses to influence resilience (Folke et al., 2010); and iii) transformability, which is the capacity to respond to untenable environmental, economic or social structures by creating a fundamentally new system (Walker et al., 2004). We only included indicators for robustness and adaptability, because transformability was considered outside the scope of the PEP. The following proxy indicators were selected: i) implementation of RE, because securing a source of power for the future increases resilience (this indicator is also used to assess *Practice adoption*); and ii) stakeholder engagement on the farm, because collaboration of farmers with peers, researchers, extension agents and policy actors regarding climate change activities can increase robustness and adaptability by being exposed to new knowledge these actors bring.

3.3.3 Data collection and analysis

The quantitative effect of the programme was estimated using a quasi-experimental approach, while for the qualitative indicators observations and semi-structured interviews were conducted.

3.3.3.1 Quantitative approach

A survey was conducted to collect data on the quantitative indicators (see Fig. 8) of *Practice adoption, Management skills and decision-making,* and *Resilience* amongst the respondents. A 20-minute phone survey was conducted targeting two groups: i) 150 farmers who were participating in the PEP (treatment group), of which 36 farmers participated in the PEP from 2010-2013 and 114 from 2014-2017; and ii) 200 non participants (control group). We obtained the contact details for the treatment group from the recorded attendance list of meetings, while contact details for the control group were recruited via a stratified randomised sample from the Scottish Government national database of agricultural producers. The survey was conducted by a professional data collection team in December 2017 and January 2018. The survey (see Appendix B.1) included questions on socio-demographic data, soil management, the production of RE, and a knowledge test.

To estimate the Average Treatment Effect (ATT) the data from the phone survey was analysed by using a quasi-experimental approach. Ten respondents were excluded from the analysis,

because they did not fully complete the survey. Hence, there were three groups for comparison, consisting of 340 farmers in total:

i) 2010-2013 PEP (*n* = 36): farmers who participated in the discussion groups of the programme in this period
ii) 2014 - 2017 PEP (*n* = 114): farmers who participated in the discussion groups of the programme in this period
iii) Control group (*n* = 190): farmers who did not participate in any of the PEP activities

We applied propensity score matching (Rubin, 1974; Stuart, 2010) to account for self-selection bias (Pufahl and Weiss, 2008; Salhofer and Streicher, 2005) on the cross-sectional dataset. We applied the approach by going through the following steps: i) estimate the propensity score of the farmers included in the survey based on the covariates; ii) match farmers from the treatment and control group based on their propensity score; and iii) check the matching quality to assure that the mean of all variables are statistically the same between the treatment and control group. The matched sample was then used to estimate the ATT.

Estimation of propensity score. A statistical summary of the matching characteristics before matching is provided in Appendix B.4, Table 8. The matching characteristics were selected based on previous studies (e.g. Läpple and Hennessy, 2015) and known not to be directly linked to the outcome variables. The multivariate analysis shows (Appendix B.4, Table 9) the importance of matching. It reveals that the PEP and control group differ on: agricultural education; rented land; limited soil type; years of experience; and presence of livestock on the farm. The latter two characteristics are negatively correlated with PEP participation, whereas the first three are positively correlated with PEP participation. By matching the PEP and control group the differences between these groups were removed, which then accounted for potential adoption bias between the groups.

Matching farmers from treatment and control group. To establish successful matches *k:1* nearest neighbour matching[1] was applied, in which the treated individuals were matched with the nearest control individuals (Stuart, 2010). Nearest neighbour matching without replacement

[1] While applying nearest neighbour matching, our results are robust to other matching techniques, such as kernel matching.

gave the best covariate distribution and there was a sufficiently large control group compared to the treatment group to apply this matching method (Stuart, 2010). To avoid poor matches a caliper of 0.25 as suggested by Rosenbaum & Rubin (1985a) was implemented, to minimise the maximum difference between the matches (Rosenbaum and Rubin, 1985b).

Quality assessment of the matching. Once matching was performed an assessment was required to analyse whether the differences in the observed characteristics were successfully removed. We used numerical and graphical diagnostics to assess the quality of the matches, which was based on the covariate balance (Stuart, 2010). In order to select the best model, which differed based on explanatory variables and model specification, we used the log-likelihood and Akaike information criterion values (Cameron and Trivedi, 2005). Matching was considered successful because the significant differences between the covariates disappeared (Appendix B.4, Table 10). Furthermore, the overall significance of the logit model should be rejected after matching (Caliendo and Kopeinig, 2008), which is observed in our model: pre-matching the likelihood ratio chi-square was significant, whereas after matching joining significance of all models was rejected. Also, the pseudo-R^2 is supposed to be low, which is observed when we compare the pre-matching (Appendix B.4, Table 9) with the after-matching (Appendix B.4, Table 10). The visual distribution of propensity scores after matching is included in Appendix B.4, Fig. 13. Lastly, a sensitivity analysis was conducted to determine the susceptibility of the results to biases not removed by the matching, such as susceptibility to unobservable characteristics (Olmos and Govindasamy, 2015). The Wilcoxon's rank sign test was used, which states the results are more resilient to hidden bias if a large change in the odds is required for statistical change to happen (Rosenbaum, 2002). The test states that for all outcome variables, i.e. *production of RE, implementation of nutrient management plan, soil testing* and *knowledge acquisition*, the lower bound estimate changes from non-significant to significant for a value of Gamma larger than 1. However, with a value between 1.0 and 1.1 the robustness of the results against hidden bias are relatively low.

Estimating the treatment effect. To compare both treatment groups with the control group after successful matching, two comparisons were made (Heckman et al., 2001):

Comparison I: 2010 – 2013 PEP farmers and control farmers

Comparison II: 2014 – 2017 PEP farmers and control farmers

Subsequently, the data was analysed by conducting a linear regression based on the outcomes of the treatment and control group and quantifying the average treatment effect on the treated group (ATT).

Comparison I: ATT_1 (Eq. 1)

Comparison II: ATT_2 (Eq. 2)

$$ATT_1 = E\,[Y(1)|D = 1] - E\,[Y(0)|D = 1] \quad (1)$$

ATT_1 is the average treatment effect on the farmers who participated in the PEP from 2010 until 2013, where *D* = 1 indicates PEP participation and *D* = 0 indicates the farmer did not participate at all. *Y* refers to each observed farmer in the participation (1) or non-participation (0) state and *E* is the expected value.

$$ATT_2 = E\,[Y(2)|D = 2] - E\,[Y(0)|D = 2] \quad (2)$$

ATT_2 is the average treatment effect on the farmers who participated in the PEP from 2014 until 2017, where *D* = 2 indicates PEP participation and *D* = 0 indicates the farmer did not participate at all.

Due to participation in the PEP, we expected a positive ATT on the performance indicators *production of RE, implementation of nutrient management plan, soil testing* and *knowledge acquisition* for the PEP farmers in Comparisons I and II (described in Appendix B.4, Table 8).

3.3.3.2 Qualitative approach

To gain insight into *Social learning, Resilience,* and farmers' perception of *Practice adoption,* qualitative data was collected by conducting semi-structured interviews (Appendix B.3), analysing meeting notes, and observing discussion group meetings. We selected the interview participants based on: i) participation in the PEP; ii) interest in participating in further research after participation in the phone survey; iii) meeting attendance: only respondents who had

attended more than two meetings were invited; and iv) geographical location, to allow inclusion of respondents from different farm discussion groups. An overview of the 20 respondents is provided in Appendix B.2. Interview themes included: i) background information related to the farmer and the farm; ii) farmers' views on participation in the PEP; iii) views on the facilitator, experts and peer interaction; and iv) practice and behavioural changes made due to participation in the PEP.

All interviews were recorded and fully transcribed and subsequently, interview transcripts were imported to content analysis software NVivo (QSR International Pty Ltd, 2018). We coded the data by identifying key concepts that were related to the pre-determined indicators depicted in the framework (Fig. 8). After using the interviews as a primary resource, we allowed for data triangulation by adding the findings from the meeting observations and notes.

3.4 Findings

The findings for each of the indicators is summarised in Table 2 and elaborated on in the subsections below.

3.4.1 Participation

Farmers were included in the 'PEP group' based on attendance records showing that they had participated in the PEP, however, a number of members of the PEP group did not recall participating in the programme: 9 respondents indicated having attended one meeting; 36 indicated having attended 2-3 meetings; 30 indicated having attended more than 3 meetings; and 75 respondents indicated not having attended any meeting. The significance of the awareness of participation is discussed below.

3.4.2 Practice adoption

The ATTs for *Practice adoption* mostly indicate positive returns. However, the semi-structured interviews show only three respondents mentioned the adoption of a practice specifically due to participation in the PEP and one respondent indicated that attending the meetings offered an opportunity to explore and reflect on current management practices, leading to a potential change:

'The likes of the cover crops ideas, I am coming around to that, but I don't know if that's specifically because of the meeting, it's maybe more the people I met at the meeting and where I discussed with what they were doing and checking whether I could give them a ring about that.'

Table 2: Estimation of average treatment effect on the treated (for quantitative indicators). *,**,* Significant at 0.1%, 1%, 5% level, respectively. The evaluation of the qualitative indicators is depicted by using '-' for a negative effect, '+' for a positive effect and +/- if the evaluation is not positive or negative. n/a refers to 'not applicable', for these indicators no data is available.**

PEP elements	Indicators	Findings		Overall assessment
		Findings 2010-2013 group	Findings 2014-2017 group	
Practice Adoption	Production of renewable electricity	0.47** (0.056)	0.27*** (0.025)	Positive, practice adoption is higher under PEP participants.
	Production of renewable heat	0.31** (0.046)	0.18 (0.023)	
	Implementation of nutrient management plan	0.58 (0.057)	0.84*** (0.03)	
	Soil testing	0.97* (0.037)	0.99*** (0.022)	
Social learning	Facilitation	n/a	+/-	Mixed, repetitive meetings are organised, but farmers only attend a small number of these meetings. This leads to lack of egalitarian atmosphere and open communication.
	Small group work	n/a	-	
	Egalitarian atmosphere	n/a	-	
	Repeated meetings	n/a	+	
	Opportunities to influence the process	n/a	-	
	Open communication	n/a	-	
	Diverse participation	n/a	+	
	Multiple knowledge sources	n/a	+	
Resilience to challenges and uncertainties	Production of renewable electricity	0.47** (0.056)	0.27*** (0.025)	Mixed, PEP farmers show higher generation of RE compared to control farmers, but the interviews show this is not attributable to PEP participation.
	Production of renewable heat	0.31** (0.046)	0.18 (0.023)	
	Stakeholder engagement	n/a	-	
Management skills and decision-making abilities	Knowledge acquisition	4.78 (0.12)	4.83** (0.07)	Mixed, farmers who recently participated in the PEP show a higher level of knowledge, whereas farmers participated >4 years ago do not.

However, other respondents could not attribute a specific change to participation in the PEP:

'I wouldn't say so that it only comes from the meetings. I think that's almost like a change in, just all the different media that you get different things from.'

Secondly, respondents discussed the implementation of nutrient management plans during the interviews. Some farmers mention implementing a nutrient plan because of the Nitrate Vulnerable Zone indicates a potential attribution problem, i.e. the farmers implemented nutrient management plans because they are obliged to do so, and not because of participation in the PEP. As discussed in the Methods section, due to the lack of geospatial data we could not correct for this in the quantitative analysis.

3.4.3 Social learning

Overall, respondents indicated that they considered the facilitators to be good organisers, well-prepared, and good at communicating. However, due to discussion groups being facilitated by different facilitators, there was variation in respondents' views. Respondents from two different discussion groups both mention the influence the facilitator had on the group, which in one case has had a positive and in the other case a negative effect:

'Facilitator x is pretty good, yes. He has been around the block a bit, he knows quite well what's going on and what we've been doing. He also tells people to shut up and go on with it, because otherwise we get very side tracked and we end up waffling on about things that aren't really relevant. But the facilitator is actually very important.'

'I didn't think it was maybe quite, I don't know if firm enough is the right word, but there should have been more leadership I think. But that's hard if that's the personalities that are involved.'

Respondents experienced sufficient opportunities to discuss with peers and experts during the meetings, in small group sessions for example. Although meetings were attended by a diverse group of participants and theoretical sessions as well as practical demonstrations were provided, respondents did not experience an egalitarian atmosphere. Respondents mentioned the lack of understanding from experts during the meetings:

'Well I manage to say things, but they all seem to think I'm crazy about what I do. It's not the normal idea.'

'The theory and practice is just too different. Until we get somebody there who understands all that and puts it in the practical sense.'

The meeting notes show eight to twelve meetings were organised for each of the focus farms. Approximately 50 percent of the interviewed farmers attended multiple meetings. Seven farmers indicated that they only attended one or two meetings, based on their interest in the topic of the meeting. Respondents' views on influencing agenda-setting were mixed, with approximately half of the farmers experiencing the opportunity to influence agenda topics:

'We actually hosted one [meeting] here, that was one of the climate things. We took people out to the hydro. It was one of the meetings connected to [focus farm x]. That would be one of the inputs that I brought in.'

The other half had the impression the agenda for the meetings was already set by the organising institution:

'I would say it was already a predetermined agenda. And they have their ideas and that's it. And they are like 'oh you can discuss it', but they didn't pay any attention.'

'I think the agenda was already set for the meetings. I never had much input into the meetings.'

Overall, the participating farmers responded positively to the meetings, the diversity of participation and the multiple sources of knowledge. There were mixed responses on agenda-setting and the facilitation of meetings, possibly due to different facilitators. Respondents generally expressed negative views about the small group work, whether the atmosphere in the meetings was egalitarian, and the openness of communication.

3.4.4 Management skills and resilience

The analysis shows that PEP participants produced significantly more RE compared to the control farmers (Table 2). However, interviewees did not attribute this change to PEP participation, but

stated that they decided to implement RE independently of the PEP, because of the financial benefit to the farm:

'It was most about diversifying, just to get another income. Because we needed another stream of income for profitability, it's just another thing to bring into the pot.'

'I thought it was an expensive fuel bill and I thought let's try to decrease that a wee bit.'

The second indicator, stakeholder engagement, shows that some respondents obtained contacts due to the meetings:

'The company I'm now buying my feed for the cows, he left his business card here when I wasn't at home that day. Then I ended up speaking with him at one of these climate change event things. From that I ended up buying feed from them. That was due to the climate change meeting. So it was worthwhile like that.'

However, there was no indication that PEP farmers involved information from more stakeholders, such as experts or advisors, in running their farms.

A significant effect for the knowledge test was only found in Comparison II, whereas participants in Group I, who participated in the PEP a longer time ago (2010 to 2013), do not show a significant effect. The implication of this result is discussed below.

3.5 Discussion

The purpose of this study was to: i) evaluate the effectiveness of PEPs in enhancing the uptake of climate friendly farming practices; and ii) contribute to the development of an effective evaluation framework for such participatory programmes. The discussion below explores the main implications of the findings in terms of the contribution of the PEP to climate friendly farming, and then draws out the main theoretical and practical implications.

3.5.1 PEP contribution to climate sustainable farming

The main aim of the PEP studied in this paper was to contribute towards climate friendly farming. The evaluation in the current paper shows that PEP participants had a higher rate of adoption of climate change mitigation practices. The positive finding of practice adoption after PEP

participation are supported by other studies conducted in developed countries (Goodhue et al., 2010; Läpple et al., 2013; Läpple and Hennessy, 2015; Tamini, 2011). The semi-structured interviews however, show that not all respondents attribute the practice adoption to the PEP. This is divergent to findings reported by Hill et al. (2017), in which self-reporting by farmers on the effect of the 'Farmer Connect' programme (a programme delivering knowledge transfer and advice to farmers in Wales) shows a straightforward positive effect. This divergence might be caused by the nature of activities in the programme, because participants in the 'Farmer Connect' programme were required to meet a share of the cost, leading to a possible overestimation of programme benefits, the optimism bias (Sharot, 2011), as the farmers may seek to justify the invested resources. Farmers are willing to pay for extension services if relevant to their needs (Ozor et al., 2013; Prager et al., 2016), but research has not yet focused on the effect co-funding in PEPs might have on farmer motivation to take up new practices. This is an area to explore in the design of future PEPs.

Another explanation of the more positive outcome of the quantitative analysis compared to the qualitative analysis, is that farmers might not attribute the adoption of practices to being concerned about climate change. A paper by Tripathi & Mishra (2017) shows that although farmers implement climate change mitigation practices, such as changing cropping patterns and agroforestry, they do not attribute that change to a motivation to contribute to climate change mitigation. Instead, they indicate that practice change is motivated by having to deal with a changing socio-economic situation, such as changing market prices. We hypothesise that something similar might be happening amongst the Scottish farmers. The climate change PEP stimulated the uptake of practices that were 'win-win': both climate and cost effective. Hence, farmers might have adapted climate change mitigation practices, but do not recognise them as such, because they have implemented these practices to make the farm more cost-effective. Thus, they do not link their practice adoption to a climate focused PEP. We find that in the qualitative interviews most farmers mentioned financial reasons as the main motivation to take up climate change practices, which supports our hypothesis of farmers not recognising climate change mitigation measures as such.

However, we question the successful sustained adoption of such practices when climate change mitigation measures are framed as cost-effective. Finding strong financial motivations to adopt

suggests that the programme achieved limited 'cultural embeddedness', i.e. where the focus for practice change is on non-economic motivations such as wider public goods and doing the 'right thing'. A common criticism of financial incentives for promoting the uptake of environmental practices is that they do not achieve long lasting change, as they fail to redefine a 'good farmer' identity (Burton and Paragahawewa, 2011; de Snoo et al., 2013; Lokhorst et al., 2011; Van Herzele et al., 2013). Historically, the dominant 'good farmer' identity has consisted of maximising on-farm production, with 'good farming' practices being 'productivist' practices (Haggerty et al., 2009), such as good crop appearance and financial viability. Climate change mitigation practices might clash with such 'good farming' beliefs: farmers are interested in uptake of farm measures that demonstrate economic success, than less tangible signs of 'good environmental farming' (Burton et al., 2008). Therefore, farmers might be less likely to adopt new, e.g. climate sustainable, practices if this does not align with the beliefs of 'good farming' (Burton, 2004a; Inman et al., 2018; McGuire et al., 2013). Hence, we question whether PEP participants are likely to take up climate change mitigation practices after programme participation if they are motivated to do so because of financial reasons. Future programmes might benefit from reimagining the 'good farmer' identity to gain embedded practice change by focusing less on financial motivations and more on social norms (Burton, 2004a).

3.5.2 PEP design

In our study, *Practice adoption* and *Social learning* might have been hampered by the lack of repeated farmer attendance at meetings. The majority of the farmers did not attend more than 2-3 meetings, whereas the literature suggests that a stable discussion group over extended periods, with personal interaction between farmers with experts or peers, is necessary for building trust and achieving behavioural change (Mills et al., 2008; Muro and Jeffrey, 2012, 2008; Sutherland et al., 2013). Encouraging farmers to attend multiple meetings might improve *Social learning* and can be enhanced by explicitly showing the 'benefits' a programme brings to farmers (Kraaijvanger et al., 2016; Mapfumo et al., 2013). Furthermore, allowing farmers to influence the choice of practices promoted by a PEP is also likely to motivate participation. Additionally, our findings are supported by the recommendation in Islam et al. (2011): the selection of group leaders and facilitators should not only be based on technological competency, but also on personality traits, such as innovativeness, sincerity and trustworthiness, and could play an

important role in successful programme design and the sustainability of the groups. Furthermore, similar to Vrain and Lovett (2016) and Cristóvão et al. (2012), our findings show the importance of increasing understanding into the influence of different facilitators on establishing a stable discussion group. Therefore, further evaluation should explore the influence of training facilitators, researchers and extension experts involved in the programme.

Lastly, results from the survey and interviews suggested that some of the PEP farmers have a poor recollection of attending the meetings, or do not associate attending meetings with the PEP when it was named. The observation of low recognition of the PEP name despite positive effects shown by participation, questions whether programme recognition matters for the success of the PEP and for future policy aims associated with such PEPs. These questions are worth exploring in further research, particularly concerning the issues of focusing on project attribution versus project impact.

3.5.3 Methods and data for evaluation

3.5.3.1 Additions to the evaluation framework

By stimulating *Practice adoption, Social learning, Resilience,* and *Management skills,* PEPs generally aim to contribute to the cultural embeddedness of the practices being promoted, and the evaluation framework might benefit from the inclusion of methods to measure the cultural embeddedness of ideas stimulated by a PEP. This could be done through the development of indicators from institutional theory which focuses on the processes involved in establishing long term change (e.g. Gray et al., 2015; Smets et al., 2012). Institutional theory studies change by looking at institutional logics, which are 'the socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, and beliefs, by which individuals and organisations provide meaning to their daily activity, organise time and space, and reproduce their lives and experiences' (Thornton et al., 2012 p. 2). The culture of farming consists of multiple logics, which are thus each constituted by a set of practices, beliefs, and values. Institutional theory states that to establish change, we need to focus on changing these logics by shifting not only practices, but also beliefs and values. Hence, when we conduct an evaluation and we want to measure sustained change, only studying the change in practices does not

provide sufficient insight. Therefore, not only practice change should be studied, but also whether it has changed the beliefs and values underlying those practices. Studying these values, beliefs, and practices can be done by interviewing farmers about their day-to-day activities and their motivations behind these activities, as well as by visiting the farm and understanding farm systems. By including farmers before and after the programme may provide insight in not only change due to the programme, but might also help in identifying the mechanisms that are responsible for this change.

3.5.3.2 Limitations of the evaluation methods

The quasi-experimental method used in this study has a limitation in terms of correctly measuring the magnitude of change. For example, in the propensity score matching unobservable characteristics cannot be taken into account, which McKenzie et al. (2010) suggest can lead to a 20% estimation bias. For the present study, this could mean that there is no significant positive effect from the PEP in reality. This concern is confirmed by the sensitivity test, which under best matching circumstances results in a Gamma value of 1.1. Although this indicates that the results may be susceptible to hidden bias, optimising the matching proved difficult. Additional matching characteristics, such as income, were asked from farmers, but the majority of the participants were not willing to share this information. This indicates a limitation of the matching based on cross-sectional survey data and underlines the importance of longitudinal data collection, in which hidden bias, via unobservable characteristics, can be accounted for. Secondly, the knowledge test used to evaluate *Management skills* only shows a significant result for farmers who recently participated in the PEP. The lack of a significant difference in the 2010-2013 group may be caused by the complexity of the knowledge disseminated by the PEP, or the effect may be too small to be detected by the econometric analysis, which has previously been observed in a study by Feder et al. (2004a). Thirdly, the qualitative interviews were only conducted with farmers who were members of the PEP group, and we were not able to interview farmers who had not participated in the PEP. Fourthly, an inherent difficulty of evaluating PEPs like these is controlling for different information channels. Farmers might receive their information via multiple pathways, such as other discussion groups, field days and the internet, which is difficult to control for when only having access to cross-sectional data.

To improve the quality of the econometric analysis and increase the accuracy of measurement, we highlight the importance of baseline data collection for future evaluation (Feder et al., 2004a). To gain insight into the motivations for making (or not making) changes on farms, we suggest that future research should also aim to conduct qualitative interviews with farmers not involved in a programme. To account for different information channels, longitudinal data collection is required, which, via for example a randomised controlled trial or the difference-in-differences approach, accounts for unobservable characteristics.

3.6 Conclusion

This evaluation contributes to the limited published information on the success of climate change PEPs. The divergence between the findings from the quantitative and qualitative method shows that the use of mixed methods is highly important to gain understanding in the overall functioning of PEPs. Furthermore, the lack of proof for sustained change leads us to suggest that programmes such as the PEP evaluated in this study need to be part of a broader suite of measures, e.g. together with regulation, subsidies, and customer pressure, as they are currently not sufficient to create a climate sustainable farming culture on their own. Further research into other PEPs would be useful, e.g. how to change farmer beliefs and values to establish long-term change. To gain insight into this long term change, quantitative and qualitative baseline data, in combination with continuous observations, might prove useful to collect new insights. This would also allow for increased insight into the processes that lead to change due to participation in extension programmes.

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4. Paper 3: Policy and practice certainty for effective uptake of diffuse pollution practices in a light-touch regulated country

4.1 Abstract

Although the link between agriculture and diffuse water pollution has been understood for decades, there is still a need to implement effective measures to address this issue. In countries with light-touch regulation, such as New Zealand and Australia, most efforts to promote environmental management practices have relied on voluntary initiatives such as participatory research and extension programmes; the success of which is largely dependent on farmers' willingness and ability to adopt these practices. Increased understanding of the factors influencing farmer decision-making in this area would aid the promotion of effective advisory services. This study provides insights from 52 qualitative interviews with farmers and from observations of 9 farmer meetings and field days. We qualitatively identify factors that influence farmer decision-making regarding the voluntary uptake of water quality practices and develop a typology for categorising farmers according to the factors that influence their decision-making. We find that in light-touch regulated countries certainty around policy and also around the effectiveness of practices are essential, particularly for farmers who delay action until compelled to act due to succession or regulation. The contribution of this paper is three-fold: i) it identifies factors influencing decision-making around the uptake of water quality practices in a light-touch regulated country; ii) it develops a typology of different farmer types; and iii) it provides recommendations on policy approaches for countries with light-touch regulation, which has potential relevance for any countries facing changes regarding their agricultural policy, such as post-Brexit policy in the UK.

Keywords: farmer behaviour, water pollution, environmental management, advisory services, extension

4.2 Introduction

Farm-level nitrate emissions contribute to surface and groundwater contamination (Mateo-Sagasta et al., 2017) and can be reduced by the uptake of environmental management practices. Such practices can be promoted by regulation, or in countries with light-touch regulatory

approaches, they can be promoted by voluntary initiatives such as participatory extension. New Zealand provides a useful example of a country with limited government intervention in the agricultural sector, as evidenced by the level of Producer Support Estimate (PSE), which refers to gross monetary transfers from taxpayers to agricultural producers. PSE is 0.5% in New Zealand compared to 20% in countries in the European Union (OECD, 2019). Due to such low policy support, initiatives stimulating the uptake of environmental practices tend to rely on the voluntary efforts of farmers (e.g. DairyNZ, 2017; Kerr and Sweet, 2008). Agriculture is one of the largest industries in New Zealand and nitrate leaching is currently one of the main challenges the sector is facing (Dymond et al., 2013). Communities, scientists, policy-makers and industries are pushing for change (NZ Ministry for the Environment, 2017; OECD, 2012), and the concept of a social licence to operate is increasingly evoked in New Zealand (Edwards and Trafford, 2016). Businesses obtain this social licence when deemed legitimate, e.g. when the values of the business and its operational processes meet the expectations of local communities and other concerned stakeholders (Dare et al., 2014). This suggests that farmers need to adopt more pro-environmental practices aligned with societal expectations of good practice (Hart, 2017; Legett, 2017).

The New Zealand agricultural sector underwent neoliberal reform in the 1980s, when most direct and indirect government support was reduced or removed (Turner et al., 2016). Due to the light-touch approach, industry bodies are closely involved in farm practice and voluntary approaches to reduce pollution, e.g. nitrate leaching, through participatory research and extension programmes (DairyNZ, 2017). Practice adoption used to be the predominant focus of the New Zealand extension models, but during the last decade there has been a change in focus by moving away from a traditional linear, technology transfer-oriented extension model into an approach where farmers become innovators, problem-solvers and co-constructors of new knowledge. These participatory research and extension activities, in which farmers, researchers and other stakeholders work together to identify good management practices (Black, 2000), have been used to stimulate the voluntary uptake of water quality practices by farmers (e.g. DairyNZ, 2017). Although the approach has been promoted, there are concerns about the effectiveness of this current extension design to support farmer learning about complex ideas (Sewell et al., 2017). The successful implementation of extension programmes requires an understanding of the initial

phases of learning and decision-making that are important to achieve change (Turner et al., 2016). To assure effective and supportive extension more understanding is needed into the factors underlying farmer decision-making regarding the uptake of water quality practices in light-touch regulated countries.

Although Bewsell et al. (2007) show that mainly material factors, such as animal health issues or additional labour, are the main motivations for adopting water quality practices, recent studies argue that understanding behavioural change in relation to the uptake of pro-environmental practices requires a holistic approach, in which personal, material and social factors that shape the decision-making context are included (Darnton and Evans, 2013; Inman et al., 2018; Mills et al., 2017; Price and Leviston, 2014). Studies focusing on the uptake of water quality practices have shown that from a personal perspective, factors linked to intrinsic motivation, such as personal beliefs and norms and self-identity are important in the adoption of these practices (Greiner et al., 2009). Personal motivations are often linked to material factors, which directly influence the productive capacity and economic viability of the farm (Burton et al., 2007; Macgregor and Warren, 2006; Oreszczyn et al., 2010; Popp et al., 2007). For example a lack of financial capital is seen as a significant barrier to adoption (Yang and Sharp, 2017). Another barrier is seen in labour availability, i.e. when adopting environmentally friendly practices leads to a more labour intensive system, farmers are less likely to adopt these practices (Dwyer et al., 2007). Furthermore, farmers can sometimes be wary of adopting practices, due to regular changes in legislation (Widdison et al., 2004). Social factors include farmer engagement with environmental advice, which might influence awareness and knowledge; in turn potentially influencing the ability to adopt new practices (Barnes et al., 2013; Rhodes et al., 2002). Blackstock et al. (2010) indicate how extended periods of personal interaction with experts or peers can develop trust and lead to behavioural change over time. Moreover, social capital, 'the links, shared values, and understandings in society that enable individuals and groups to trust each other and so work together' (Keeley, 2007), may also influence uptake of environmental practices by farmers who are strongly embedded in a community (Greiner and Miller, 2008).

Besides focusing on a holistic decision-making model, studies also acknowledge heterogeneity in the factors influencing farmer decision-making (P. Brown et al., 2016; Burton and Paragahawewa, 2011). This led to classifications of farmers, which were based on ethnicity, class,

wealth and farm size. Classifications based on these characteristics did however often not align with actual farming practice (Phillips and Gray, 1995). Subsequently, studies emerged using farmer styles theory, which explains diversity in practices by using farmers' own worldviews. It however proved difficult to identify specific farmer styles in practice (Howden and Vanclay, 2000). Classifications by Barnes & Toma (2012) and Barnes et al. (2011) looked into farmer decision-making specifically around the uptake of environmental practices by applying a quantitative approach in which respondents were asked to rank predefined statements to develop a categorisation. However, these classifications only focused on perceptions, values and behaviours of farmers and did not include the relation to material factors, such as finance and farm size. A recent classification has been based on the differing extent to which individual, material and social factors influence farmer attitudes and behaviours (Mills et al., 2017), in which farmer types were inductively identified, i.e. by using primary data to identify factors, within a priori determined categories. This work was however conducted in a tightly-regulated country. Qualitative work addressing farmer motivations has been done in New Zealand, but only included a subsection of the farmer population (Bewsell et al., 2007), which hinders generalisability.

Based on previous studies we identify three gaps in the current literature on farmer decision-making around diffuse pollution practices. Firstly, most studies identifying factors influencing decision-making around the uptake of environmental practices are conducted in tightly regulated countries, such as the UK (e.g. Barnes et al., 2009; Mills et al., 2017), which leaves uncertainty around what the most important decision-making factors are in light-touch regulated countries, such as New Zealand. Secondly, there is only limited work focusing on how knowledge of the factors influencing decision-making and the heterogeneity in these factors can be used for the design of effective extension (P. Brown et al., 2016; Burton and Paragahawewa, 2011; Sewell et al., 2017). Thirdly, there is a lack of inductive studies which identify generalised types or findings from the data without being guided by previous theory. The majority of recent studies have focused on identifying factors influencing farmer decision-making by using a quantitative approach in which respondents were asked to rank predefined statements (e.g. Barnes et al., 2011; Barnes and Toma, 2012). In contrast, this paper applies an inductive approach to identify the factors that influence farmer decision-making in relation to the voluntary uptake

of unsubsidised diffuse pollution practices in a light-touch regulated country, with the aim of using the identified factors to make recommendations on extension design. We selected the agricultural sector in New Zealand as a case study, because in recent decades, the impact of land use activities on water quality has been of increasing concern for scientists, industries, policy-makers and wider society (Roy, 2019), and the New Zealand agricultural sector is characterised by light-touch regulation. Furthermore, change so far has been based on voluntary initiatives, but concerns have been raised regarding the effectiveness of current models and the extent to which these support practice-based innovation and farmer learning. Thus a better understanding of the farmers and their decision-making is crucial to inform policies that promote the uptake of good practice (Sewell et al., 2017). The contribution of this paper is three-fold: i) it applies an inductive approach to identify factors influencing decision-making around the uptake of water quality practices; ii) it develops a farmer typology to reflect the way different types of farmer are influenced by different decision-making factors; and iii) it provides recommendations on policy approaches and extension in countries with light-touch regulation, which has potential relevance for any countries facing changes regarding their agricultural policy, such as post-Brexit policy in the UK.

4.3 Methods

4.3.1 Study region

Canterbury in New Zealand's South Island was selected as our study region, because of its importance in the agricultural sector, accounting for approximately 20% of national agricultural land (Stats NZ, 2017). In addition, it has been the location of a participatory research and extension initiative since 2013: Forages for Reduced Nitrate Leaching (FRNL) (DairyNZ, 2017). This initiative involves a co-innovation approach between researchers, rural experts, and a group of farmers in Canterbury: four dairy farms; two arable farms; two sheep and beef farms; and one mixed arable and dairy farm. This group of farmers was used as an access point for observations and interviews during the study.

4.3.2 Study method

To explore farmer decision-making regarding the uptake of water quality practices we used a qualitative approach, including semi-structured interviews, meeting observations, and meeting notes as our primary data. We conducted 52 in-depth face-to-face interviews with 26 dairy farmers, 10 sheep and beef farmers, 9 arable farmers, and 7 mixed farmers (Appendix C, Table 11). All interviews were recorded and fully transcribed. We also conducted observations during 5 meetings between farm advisors and farmers, 1 discussion group meeting, and 3 field day meetings.

Appendix C.1 details the interview structure, designed to provide insight into factors influencing decision-making and engagement with diffuse pollution reduction practices. The themes that were covered were: i) background information related to the farmer and the farm; ii) farmers' views on nitrate leaching; iii) nitrate management changes farmers had implemented during the last decade and farmers' motivation behind that change; and iv) factors that influenced farmers' decision-making regarding the uptake of nitrate leaching measures.

4.3.3 Sample selection

To ensure the selection of a representative sample for the nitrate leaching issues in Canterbury, respondents from three groups of the Canterbury farming population were included. These respondents represented different levels of knowledge and engagement in environmental practices and extension initiatives. The first group, the 'FRNL farmers', consisted of farm owners and managers who were part of FRNL and thus demonstrably engaged in nitrate reduction practices. At the time of the research, monitor farms had been part of FRNL for approximately four years, during which they had gained experience in being part of a participatory research and extension programme and had been introduced to a range of practices to reduce nitrate leaching. All FRNL farmers participated in the interviews. The second group, the 'Network farmers', consisted of farmers who were part of the informal network of members of the first group. They were identified using snowball sampling, in which the FRNL farmers were asked to identify peers they were regularly in contact with. We conducted 18 interviews with farmers in this group. To get an overview of the decision-making factors of farmers in the network we interviewed at least one Network farmer per FRNL farm. The third group, the 'External farmers',

consisted of farmers who had little or no involvement in environmental extension activities and had no network links. These farmers were suggested to us by key informants, also known as extension agents. The External group functioned as a 'control' group, assuming that these farmers had received little information via extension activities regarding nitrate leaching reduction practices. Twenty-two interviews were conducted with farmers in this group.

Five farmers rejected the invitation to participate in the interviews. Two of these farmers were Network farmers and three were External farmers. The rejection rate amongst the Network farmers was low, because FRNL farmers sent out a message to these farmers before they were invited to participate in an interview. This increased their willingness to participate. The two farmers who rejected the invitation indicated that they were too busy at the time of data collection. We do not have any additional data available on these farmers. The three External farmers who rejected the invitation were dairy farmers who were also too busy at the time of data collection. The rejection rate was low, because all External farmers had received an information email from a key informant before being invited for the interview, increasing their willingness to participate in the research. Again, apart from the contact details we did not receive any additional data on these three farmers.

The sample of farmers included in this study was intended to be representative of the nitrate leaching issues in Canterbury. Therefore, instead of representing the absolute distribution of farming types, the FRNL programme represented the sector according to nitrate leaching issues. This resulted in the inclusion of 56% dairy farmers, 22% sheep and beef farmers and 22% arable or mixed farmers. Consequently, the research sample consisted of 50% dairy farmers, 23% sheep and beef farmers and 27% arable or mixed farmers. The sample, with an average farmer age between 40 and 50 years old the sample represented the average age of New Zealand farmers, which in 2013 was 47.7 in the 2013 agricultural census (Stats NZ, 2013).

4.3.4 Data analysis

The data analysis was conducted in two phases. In phase 1 the data was analysed to identify factors influencing decision-making regarding diffuse pollution reduction practices. In phase 2 we developed a typology to reflect the different factors influencing decision-making for different types of farmer.

Phase 1 analysis applied an inductive approach, drawing on Gioia et al. (2013). This sets out a systematic approach for concept development including the formation of a wide range of first order concepts before systematically placing them in second order concepts. An example of the data coding structure is attached in Appendix C.2. Using content analysis software NVivo 12 (QSR International Pty Ltd, 2018), we undertook an initial round of coding, using the interview data to identify first order concepts. We then undertook a second round of coding, using the data from the observed meetings, to refine and substantiate the initially identified factors, which led to the formulation of second order concepts. As part of this second round of coding, we categorised the factors under three main dimensions, *Personal*, *Material*, and *Organisational*. In this study, we refer to the *Personal* dimension when we talk about farm-level influences regarding individual beliefs and attitudes and household dynamics. The *Material* dimension includes rules, regulation and infrastructure. The *Organisational* dimension is about the involvement in networks, relationships, and research and extension activities.

Our inductive analysis showed early in the research process a heterogeneity in farmer decision-making, which was explained by different dominant factors in the *Personal, Material,* and *Organisational* dimensions. Therefore, phase 2, developed a typology of different farmers based on the heterogeneity in decision-making factors that was observed in the dataset. To address this systematically, we attributed a 'low', 'medium', or 'high' weighting or a binary 'yes' or 'no' to each of the factors in the *Personal, Material,* and *Organisational* dimensions to indicate the importance of the specific factor for each respondent.

4.4 Findings

4.4.1 Phase 1: Identifying decision-making factors

We identified a total of 16 factors influencing decision-making around the uptake of environmental practices, which we have depicted in Figure 9. The figure indicates that these factors fall into three categories, the *Personal, Material,* and *Organisational* dimensions. Furthermore, the arrows indicate the interaction between each of the dimensions.

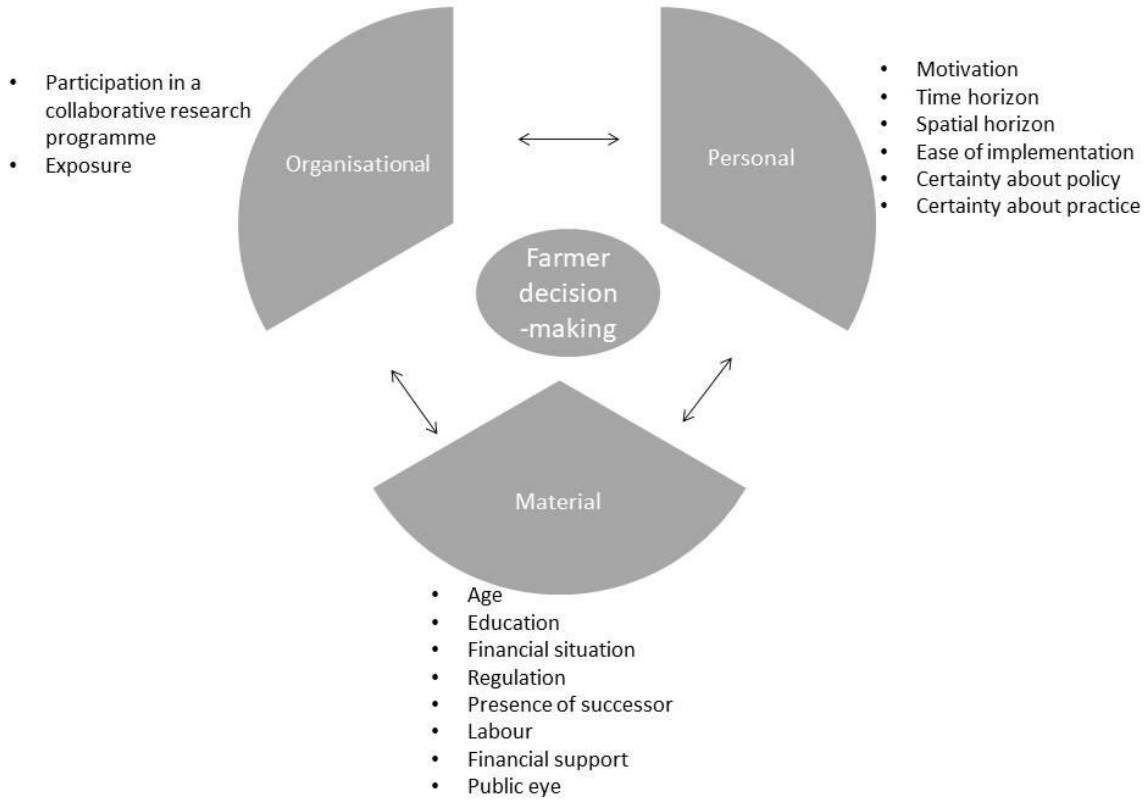

Figure 9. Schematic diagram of the factors influencing farmer decision-making in relation to the uptake of water quality practices.

The content analysis identified six main factors in the *Personal* dimension:

- *Motivations*: the extent to which farmers expressed intrinsic *motivations* for implementing measures. Farmers with strong intrinsic *motivations* made statements in relation to a green self-identity and personal beliefs and attitudes, such as adopting environmental measures because of 'wanting to do the right thing'. *Motivations* were classified as 'high' when intrinsic *motivations* were strong, opposed to 'low' when intrinsic *motivations* were low.
- *Time horizon*: whether or not farmers made a connection between their current farm management and the effect it may have on future generations.
- *Spatial horizon*: the difference between farmers looking within their farm gate, versus an outward perspective, such as the catchment level or wider New Zealand society. It

classifies how farmers perceived the connection between their on-farm activities and water quality issues outside the farm. The spatial horizon was 'inward' (as opposed to outward) when the farmer only looks within the farm boundaries.

- *Ease of implementation*: how easy farmers perceived the implementation of a new practice.
- *Certainty about policy*: whether there was certainty around the policy goals.
- *Certainty about practice*: whether there was certainty around which practices are most effective to implement.

The content analysis identified eight main factors in the *Material* dimension:

- *Age*: age of the interviewee.
- *Education*: the level of education of the interviewee.
- *Financial situation*: the extent to which the farmer experienced money to be available for investment in environmental practices.
- *Regulation*: whether there was regulatory pressure to reduce nitrate leaching.
- *Presence of a successor:* the presence of a successor to take over the farm.
- *Labour*: size of the business and amount of labour available on the farm.
- *Financial support*: the availability of financial support to implement an environmental practice. This support came from the public or private sector.
- *Public eye*: The farm was directly visible to the community, by either being located near a main road or touristic area.

From the data analysis, we identified two main factors in the *Organisational* dimension:

- *Participation in FRNL*: participation in the FRNL participatory research and extension programme.
- *Exposure*: participation in meetings other than those of a participatory research and extension programme, for example farmer discussion groups, zone committee meetings, and farmer field days. Exposure was 'high' when farmers participated in initiatives on a regular basis. Exposure was 'low' when farmers did not participate in initiatives at all, or only sporadically attended meetings.

Table 3. Overview of the personal, material and organisational factors constituting the types of farmers.

Types	Share of farmers		*Personal*						*Material*							*Organisational*	
	Farmers	%	Time horizon	Focus	Intrinsic motivation	Ease of implementation	Certainty about policy	Certainty about practice	Financial situation	Presence of successor	Labour	Regulation	Age	Financial support	Public eye	FRNL	Exposure
Perpetuate Cooperates	3	6	Long	Outward	High	High	High	High	High	Yes	High	High	Low	Low	Low	Yes	High
Enthusiasts	20	38	Long	Outward	High	High	High	High	Medium	Yes/no	Medium	Medium	Average	Medium	Low	Yes	High
Opportunists	16	31	Long	Inward	Low	High	High	High	Medium	Yes/no	Medium	High	Average	High	High	No	High
Bystanders	9	17	Long	Inward	Medium	High	High	High	Low	Yes	Low	Low	Average	High	Low	No	Medium
Avoiders	4	8	Short	Inward	Low	High	High	High	Low	No	Low	Low	Average	Medium	Medium	No	Low

4.4.2 Phase 2: Identifying farmer types

The observation of the trends in the importance of the factors in the *Personal, Material,* and *Organisational* dimensions led us to identify five types of farmers, which reflect the difference in factors influencing decision-making. Firstly, we noticed that there is a subgroup of farmers who showed a strong intrinsic motivation to adopt environmental practices, and who apparently have longer time horizons. However, members within this group differed regarding the financial resources and labour they had available to invest in environmental practices. Hence, this led us to create two groups of farmers with strong personal motivations, but differences in the availability of financial and labour resources. We named these farmer types the '*Perpetuate Cooperates*', referring to the group with strong personal motivations and financial resources, and the '*Enthusiasts*', referring to their personal enthusiasm, but acknowledging the limited availability of finance and labour. Secondly, we identified a type of farmers who were very business oriented, and though open to adopt environmental practices, showed a lack of intrinsic motivation. We named this type the '*Opportunists*'. Third, we identified a final type of farmers who were not very engaged in environmental management. However, there was still a slight difference in their outlook on adopting environmental practices, related to succession. Hence, a sub-group willing to adopt environmental practices because they felt it was necessary from a succession perspective were called the '*Bystanders*'. The remaining sub-group who saw no reason to get involved were called the '*Avoiders*'.

Table 4. An overview of the distribution of the interviewee groups for each of the categories.

Interviewee groups	Number of farmers in group	Perpetuate Cooperates		Enthusiasts		Opportunists		Bystanders		Avoiders	
	Farmers	Farmers	%	Farmers	%	Farmers	%	Farmers	%	Farmers	%
FRNL farmers	12	2	17	6	50	4	33	-	-	-	-
Network farmers	18	1	6	6	33	4	22	4	22	3	17
External farmers	22	-	-	8	36	8	36	5	23	1	5

The type of farmer and the importance of the factors are depicted in Table 3 and the division of the interviewee groups per type is depicted in Table 4. Table 3 does not include the *Material* factor 'education', because although farmers mentioned *Education* as an important factor in

changing their views on water quality management, we did not specifically ask for farmers' level of education during the interviews and thus could not analyse the influence this factor had on their decision-making.

Although there is heterogeneity observed in the dataset, with regard to factors influencing decision-making, there were also a number of factors of importance to all farmers. Firstly, all farmers indicated that the practices had to be easy to implement, which is for instance indicated by respondent 6:

'If it requires a whole lot more work, well then farmers in general are going to push back on the need to do it. If it's easy to do than the uptake is going to be quicker and better. That's probably just human nature really, rather than those sort of farms that are leaders of doing things like that, adopting new technologies or adopting new practices.'

Besides ease of implementation, there was a need for certainty about policy development before implementing new practices, as illustrated by respondent 12. This interviewee indicated that he delayed implementation of changes due to uncertainty on a policy level:

'I think the way we farm here in Canterbury is going to change quite dramatically in the next probably decade or so [..] So that's part of the reason why I'm not sort of rushing to make big changes just yet so that you can you know in my opinion I can see a little bit of a groundswell of change coming. I don't want to make a big change now and then have to completely redo it again in another five or 10 years so – yeah, sort of just trying to buy myself a little bit of time to see where things – where the dust settles, I guess.'

This uncertainty was confirmed by respondent 37 and respondent 46. They both indicated that conflicting information is increasing the difficulty to implement changes on farm:

'Conflicting information is becoming more and more frustrating as we're getting further into our farming career and we want direct, honest, accurate answers. We don't want to be wading through a whole lot of this side and that side trying to make decisions ourselves about what's correct. We want to be told what's right, so that then we can try and implement our farm systems to suit.'

'Noting down an answer can be quite difficult sometimes, we never quite know where we get to. [..] it's just that, I don't know, it's a lot of ducking and diving and no one is held accountable. We are accountable, but people give us advice about we can do this, or that, but no one really puts a stick in the ground of what is actually supposed to happen.'

The following sub-sections provide a more detailed description of the farmer types identified.

4.4.2.1 Perpetuate Cooperates

Three respondents, part of the FRNL and Network farmers, fell into the category *Perpetuate Cooperates*. From the *Personal* dimension, the *Perpetuate Cooperates* had a long time horizon, an outward spatial horizon and strong intrinsic motivations. From the *Material* dimension, they had the financial resources and labour force available to enable investment in mitigation options. The *Perpetuate Cooperates* aimed to enhance employment opportunities amongst the indigenous population, and did not intend to sell their land. Respondent 1 described how these factors shape the management of the farm by talking about the bottom line:

'So, we've got financial and production, what runs the business and then we've got the social, cultural aspect and we've got the environmental and they're the main goals, and then everything else links in between it, so yeah, they're the three main drivers that run [our business].'

The farms of *Perpetuate Cooperates* were part of a larger business structure, which was not only active in the agricultural sector, but also in other business sectors such as real estate. This broader focus gave these farmers a unique position that allowed them to invest in environmental practices. Respondent 2 emphasised this:

'To be fair, not all farmers are in that position [..] It's not that you don't want to do things, but you have to pay the bills. We're fortunate with [our business] that we have that backing and that support to do that from day one.'

From the *Organisational* dimension, they were highly engaged in research and extension activities, which allowed them to keep up-to-date with recent developments.

4.4.2.2 Enthusiasts

The largest share of respondents, 20, fell into the *Enthusiasts* category. The respondents were part of the FRNL, Network and External farmer group. From the *Personal* dimension, the *Enthusiasts* had a long time horizon, an outward spatial horizon and strong intrinsic motivations. Respondent 13 indicated that taking care of the environment is important, which is strongly related to their outward spatial horizon:

'We prefer to do it [implement environmental practices] because we want to. And it's the right thing to do, not just for us, but for our wider community, as well.'

From the *Material* dimension, this group had restricted financial resources and labour force, both mentioned as barriers to adopting environmental practices. The main difference between the *Perpetuate Cooperates* and the *Enthusiasts* can be found in this *Material* dimension. The *Perpetuate Cooperates* made more financial resources available for water quality management than the *Enthusiasts*. Due to limited financial resources, the *Enthusiast'* focus often needed to be within the farm gate, as articulated by Respondents 8 and 9:

'The importance is always going to be on the crop and if it's a choice between working in some oats and sowing a commercial crop, the crop will come first. It has to. The others are not a luxury, but they are very much second best. We do it if we can.'

'You know because if something is not financially viable, then any wish list you've got can't be achieved. I think that's where the environmental thing has to, I mean environmentally aware farmers are the ones that are basically making money, or can do something about it. Once they can't make money, or they don't have the money to spend, it does not work.'

Both respondents talk about the trade-off between wanting to do the 'right thing' for the environment, versus financial imperatives. This forces the *Enthusiasts* to make a financial decision to be able to maintain a viable business, in contrast to the *Perpetuate Cooperates,* who are facing this trade off to a lesser extent. From the *Organisational* dimension the *Enthusiasts* were highly engaged in environmental programmes.

4.4.2.3 Opportunists

The *Opportunists* category consisted of 16 farmers, who were part of the FRNL, Network and External farmer group. From the *Personal* dimension they were characterised by a long time horizon, an inward spatial horizon and low intrinsic motivations. From the *Material* dimension, they had sufficient financial resources and labour force available, which allowed them to adopt environmental practices. The *Opportunists* differed from the *Perpetuate Cooperates* and the *Enthusiasts* in material factors such as regulation and public perception; as is indicated by Respondent 38:

'Well as I say, it influences really in terms of like – as I say, if we're going to have these lovely native plants along our roadside, we're going to do it here where the public are, rather than doing it somewhere where no one goes.'

Respondent 29 mentioned how he experienced public perception:

'It's like farmers are like somebody in town running their business with their doors open. So it's like leaving the board room doors open, so everybody can hear and see everything. So you get people driving past and they look at something we are doing and they make an assessment and a judgement based on their limited knowledge of, not only of agriculture, but of what is going on day-to-day on this farm.'

This showed the farmers were aware of changes to reduce environmental impacts and were driven by the public eye in making these changes. The large size and associated high labour force of the farms allowed focus on the strategic management of the farm to identify which decisions were best from a strategic long-term perspective. From the *Organisational* dimension the farmers were highly engaged in environmental programmes.

4.4.2.4 Bystanders

The fourth category, the *Bystanders*, consisted of 9 farmers who were part of the Network and External group of respondents. From the *Personal* dimension the farmers had a long time horizon, an inward spatial horizon and low intrinsic motivations. From a *Material* dimension, they

had limited financial resources and a limited labour force that restricted them from adopting environmental practices.

From the *Organisational* dimension the farmers were not really exposed and engaged in environmental programmes, which influenced their knowledge on environmental practices. This showed a big difference between the *Opportunists* and the *Bystanders*. *Opportunists* showed high awareness of environmental regulation and the requirement for environmental protection, which they sometimes used to 'play' the system. However, *Bystanders* showed low awareness and had low interest in strategic decision-making. This caused them to wait longer before they made a change. This was illustrated by Respondent 46, who talked about his engagement in mitigating diffuse pollution:

'It would be interesting to see how that [environmental regulation] goes. I go through stages. I get quite into it and then I lose interest and I think stuff it and I sit on my hands and do nothing. A thing that I do enjoy is going out farming and growing things and watching them grow and trying things. I am quite keen to try and look after the soil and as for this side of it, it comes and goes. I will be paying attention for a while, but then it gets a bit hard, and we are not feeling like we are getting anywhere.'

Another characteristic of this group and a main difference compared to the *Opportunists,* was the low pressure to change; they were not located in the public eye, e.g. not located near a main road or in regions subject to strict regulation.

4.4.2.5 Avoiders

The fifth category, the *Avoiders,* consisted of four Network and External farmers who showed a short time horizon, an inward spatial horizon and low intrinsic motivations. They were usually looking at what works on- farm, and not at what happens beyond the farm gate. This was illustrated by respondent 51:

'I am not a politically correct type of person, I just put my head down, do my work and don't get too involved in that kind of stuff, because it just goes over my head to be fair. I just do my thing and get on with it, until I get told I am not allowed to do it, I am just going to keep on doing it.'

The same farm-centric view was shared by Respondent 49:

'I am off the radar. [..] I am aware that I perhaps should have [made an environmental plan], but over the years all I've ever heard is that Overseer[2] has had its shortcomings. Overseer has changed all the time and I haven't felt the need to do it, because I don't think we are leaching a lot of nutrients in the rivers. And with the jolly programme, we have to keep redoing it, so I have just paused it off. So, some of the advice is do nothing until you really have to.'

From a *Material* dimension, this group had limited financial resources and limited labour available which restricted the adoption of pro-environmental practices. The farmers in this group were, similar to the other farmers in their awareness of public scrutiny and how it might influence their licence to operate, as illustrated by respondent 50:

'Any [environmental] mistake you make you can see for a long way off when you're up in the air. So yeah, there is always that to keep on top of but yeah. [..]And if we don't draw attention to ourselves then we're obviously doing okay. Yeah, so that's probably our biggest thing is to operate outside of the radar. That's probably the goal I guess, so yeah.'

Most of these farmers did not have a succession plan and therefore had a short-term mind-set, focused on how to maximise property value to be able to sell the property well. This was illustrated by Respondent 49:

'If you would have asked me [about my goals and ambitions] years ago it would have been to develop the farm into a sustainable, profitable business to be available for my children. Now to answer that question [..] I need to keep farming and set it up to be able to sell in case my children don't want to go farming. So I guess I want to make a profit for the next ten years from farming and then have the farm available to sell if [son or daughter] don't wish to come home. I guess that's where I am at.'

[2] Overseer is a software tool in New Zealand that enables farmers to look into nutrient use and farm profitability (https://www.overseer.org.nz/) and is increasingly used as a regulatory tool.

4.5 **Discussion**

This study shows that a combination of *Personal*, *Material* and *Organisational* factors influence farmers' decision-making regarding the uptake of water quality practices and we have used this to derive a typology for categorising different types of farmers. The findings from the study show that in a light-touch regulated country certainty around practice and policy is essential, especially for farmers who are not likely to make changes until compelled by succession or regulation. The first part of this Discussion section focuses on the factors influencing farmer decision-making and how these factors differ to factors identified in tightly regulated countries. The second part focuses on the typology and the lessons we can draw for the design of extension programmes.

4.5.1 Factors influencing farmer decision-making

4.5.1.1 Novel decision-making factors

Farmer decision-making is known to be influenced by a wide range of factors (Inman et al., 2018; Mills et al., 2017; Waters et al., 2006). An important contribution of this study to the current literature is the identification and inclusion of the factors *Time horizon* and *Spatial horizon,* as the perception of farmers regarding these two factors has not been included in previous studies, although diffuse pollution is known to be 'invisible' to farmers, which affects their motivation to act upon it (Macgregor and Warren, 2006). These factors are likely to be less relevant to the adoption of environmental practices that have visible outcomes, such as conservation efforts or biodiversity practices (de Snoo et al., 2013; Mills et al., 2018; Truelove et al., 2014; Van Herzele et al., 2013), but will be more relevant for practices that have seemingly distant effects (both in time and space) such as climate change (Geoghegan and Leyson, 2012). The results of our study imply that communication on nitrate leaching practices needs to be tailored for farmers with short time and space horizons. A separate consideration is that although a small proportion of respondents mention *Age* as a factor, we did not find conclusive evidence of this being an influential factor in the decision-making. This finding accords with evidence in Kuehne et al. (2017).

4.5.1.2 The interaction of decision-making factors

Although we have provided a typology of farmers we want to highlight that farmers can change type over time, due to changes in their *personal, material,* and *organisational* characteristics. For example, previous research shows that focusing on financial benefits can decrease the intrinsic motivation of farmers, e.g. moving from wanting to do the 'right thing' to adopting practices because of financial incentives (Lokhorst et al., 2011; Van Herzele et al., 2013). Education and participation in extension programmes is also often mentioned as an important factor influencing motivation. For example, joint participation of researchers, farmers, and experts in a PEP can promote the development of farmer self-efficacy, and this can change identities and behaviours (Sewell et al., 2017), e.g. moving farmers away from financial incentives towards the development of a green identity. This entails that interventions should not only be tailored to different farmer types, but can also aim at moving farmers from one type to another.

4.5.1.3 The influence of light-touch regulation

There are two material factors that limit the voluntary uptake of unsubsidised diffuse pollution mitigation practices for all farmers. Firstly, there is the difficulty in dealing with uncertainty around policy and tools used for regulation and the effectiveness of practices. Although the regulation on nitrate leaching in New Zealand has become stricter over the last decade, in most areas there is still a high degree of uncertainty regarding nitrate leaching limits and the extent to which regulation will be enforced. Farmers indicated that lack of certainty limits investments and thus inhibits change. We suspect that farmers in a country such as the UK, which is facing a redesign of its agricultural policy, are in a similar position of dealing with uncertainty around how future support will be directed. Since we observed uncertainty to be a large decision-making factor it needs to be minimised by, for example, setting clear mitigation targets and by assuring the effectiveness of a practice. Secondly, 'ease of implementation' is another often overlooked factor (Kuehne et al., 2017). Proposed practices often differ greatly from existing farm management and will not be adopted if there is no compensation available to overcome the costs associated with increased management or implementation complexity.

In conversations with different types of farmers we identified the importance of a social licence to operate in New Zealand. *Opportunists* often referred to this as 'being in the public eye' and 'not being able to close the doors of the board room'. Dairy farmers in particular express the need to respond to increasing public scrutiny of the industry. Future research should seek to increase understanding of how it is possible to legitimise farming in a changing societal context, especially in comparison with countries where the government plays a more prominent role in the agriculture sector. Findings from the literature in organisational studies would be useful in this regard, for instance, Micelotta et al. (2017) provide an overview of possible pathways to establish and legitimise change.

4.5.2 Typologies in research and extension

This study has presented five farmer types, which represent the differences in factors influencing decision-making related to the adoption of environmental practices. By using an inductive approach we were able to assess the range of factors mentioned by the farmers without dismissing any diverse meanings that emerged from the interviews and observations (Denzin, 1971). Quantitative analysis would not have led to this depth of understanding, since a quantitative analysis would have focused on the prevalence and relationships between pre-established variables. However, we do see the value in quantitative follow-up research, which would allow us to explore whether farmers identify themselves with the suggested types. Classifying farmers has been used previously in order to target extension activities, since the influence of social, cultural, economic, and physical factors on decision-making causes farmers to respond differently to encouragement to change their farming practices (Bewsell et al., 2007; Waters et al., 2006). Increasing understanding into the factors influencing decision-making and how these factors are segmented in the farmer population will help identify which extension services suit what type of farmer and which farmers to target in voluntary research and extension projects.

The next section discusses the potential lessons from our typology for the design and implementation of extension programmes. Although the typology is based on the types evident within New Zealand, it is likely that similar types, with the possible exception of *Perpetuate*

Cooperates, will be present in other countries with light-touch regulation, and therefore the implications for extension design will also apply more broadly.

4.5.2.1 Implications for designing research and extension based on the farmer type

Extension services for the *Perpetuate Cooperates* should focus on ensuring these farmers have access to the latest knowledge and developments. However, due to their unique business structure (corporates or trusts with many shareholders or members), it is questionable whether these farmers should be targeted to set an example for the wider farming community in their region. It is also worth noting that the *Perpetuate Cooperate* type may not be common beyond New Zealand, though this should be explored in future research.

Considering the limited financial resources compared to the *Perpetuate Cooperates* it might be important for the *Enthusiasts* to create a good fit with current management practices by focusing on how to combine financial and environmental aspects in best management practice to overcome the value-action gap (Burton et al., 2008; Mills et al., 2018). On the other hand, previous research shows there is a chance that focusing on economic gain changes farmers' decision-making from based on intrinsic motivations (wanting to do the 'right thing') to material factors (e.g. participating because of financial incentives) (Lokhorst et al., 2011; Van Herzele et al., 2013). Hence, emphasising the economic gain from adopting pro-environmental practices requires careful consideration, but as shown by Bewsell et al. (2007), emphasising general additional benefits, such as reduction in animal health issues or reduction in labour intensity due to a new practice, might be important to make farmers take up new practices. In addition to the framing of practices, *Enthusiasts* might benefit from education via interaction with peers and experts (Blackstock et al., 2010). For instance, via participatory programmes including a co-innovation approach, in which multiple actors from different backgrounds participate in an iterative process bringing together knowledge to support on-farm changes (Klerkx et al., 2010).

The *Opportunists* require advisory services that focus on changing motivations, so that farmers base their decision-making on intrinsic motivations instead of material factors, which supports enduring behavioural change. Changing decision-making can be achieved by participation in social groups, which can lead to the reinforcement of a 'good farmer' identity (Burton and

Paragahawewa, 2011; Mills et al., 2017; Sutherland et al., 2013). Like the *Enthusiasts,* this group would be suited to involvement in participatory programmes.

The *Bystanders* and the *Avoiders* might be difficult groups to engage with. Their lack of involvement and interest in environmental change means that current voluntary extension initiatives may be insufficient (Inman et al., 2018). Although both groups might benefit from involvement in education initiatives, it might be most efficient to provide certainty on where they need to be (e.g. through regulation or sector programmes), or to target them indirectly via peer pressure, such as 'neighbour mimicry' or 'over-the-hedge farming', in which informed farmers set an example and then have surrounding farmers take up the practice as well (Burton, 2004a).

Based on the characteristics of the farmers, we argue that effective extension should target different farmer types in different stages. *Enthusiasts* or *Opportunists* are the most effective to target for participatory research and extension initiatives, because they are open to new practices and their businesses show high similarity to other farms. They can therefore serve as exemplars (P. Brown et al., 2016). Targeting *Enthusiasts* and *Opportunists* who are surrounded by *Bystanders* and *Avoiders* could lead to mimicry or over-the-hedge farming, since these two groups of farmers are less likely to get directly involved in extension activities. Targeting the latter two groups would happen in later stages of extension, when *Enthusiasts* and *Opportunists* have successfully implemented changes. Hence, knowing different farmer types and their locations can be used to optimise engagement and can positively influence the voluntary uptake of environmental practices. With regard to identifying a farmer network as well as the types present in a certain area or network, we firstly suggest asking farmers which peers they are in touch with, as well as who their neighbours are. Consequently, types can be identified by asking farmers about their labour availability, age, education, presence of succession, whether the farm is located near roads or touristic areas and engagement in extension activities. This might be enough to create a rough categorisation and help in how to target farmers in a certain area.

4.5.2.2 The influence of the FRNL extension initiative

The sample for this research was based around the FRNL participatory research and extension programme. The results show that the FRNL farmers are part of the *Perpetuate Cooperates, Enthusiasts* and *Opportunists,* three groups which show high awareness of environmental practices. Considering the programme was initiated four years before the interviews were conducted, there is a possibility the high awareness of water quality practices and the intrinsic motivation of some of the FRNL farmers can be attributed to the extended period of personal interaction with experts and peers (Mills et al., 2008), and seeing peers involved in environmental learning (Oreszczyn et al., 2010; Sligo and Massey, 2007). In future research it would be beneficial to conduct baseline interviews, to assess the progress made by farmers due to participation in such an extension programme.

Previous literature shows that verbal communication between farmers and peers is a key source of information (e.g. Oreszczyn et al., 2010; Wood et al., 2014). Based on this we expected most of the Network farmers, who are in direct contact with FRNL farmers, to show a high level of awareness and thus to fall into the *Enthusiasts* or *Opportunists* category. However, 39% of the Network farmers fell into the *Bystanders* or *Avoiders* category, which means there is a large share of farmers who are not engaging with environmental practices. Although our sample is too small to detect any significant differences, a suggestion is made by Feder et al. (2004b), that this is caused by the complexity of the information, which is not easily transferred in informal (verbal) farmer-to-farmer communication. Hence, it would be helpful for designing environmental research and extension programmes to explore this in more depth, by identifying which topics are discussed within the farmer networks and whether using informal networks is an effective tool for knowledge diffusion of complex topics such as nutrient management.

4.6 Conclusion

This paper applies an inductive research approach to identify the factors that play a role in farmer decision-making in relation to the uptake of mitigation practices for diffuse water pollution in a light-touch policy context. The typology derived from our dataset supports the view that engagement on mitigating diffuse pollution should entail a range of approaches tailored to the needs of different farmer types. Compared to studies conducted in tightly regulated countries,

we identify certainty about policy and certainty about practice implementation as two highly important factors in light-touch regulated countries, because there is no subsidy available to 'trial' a new practice or to compensate for costs incurred by the complexity of implementing a new practice.

The identification of farmer types is of use for policy and extension design. Extensionists should identify the types of farmers present in their target area, by identifying characteristics such as their labour availability, age, education, presence of succession, whether the farm is located near roads or touristic areas and engagement in extension activities. Consequently, they can use the differences between farmers to positively influence the voluntary uptake of environmental practices via e.g. neighbour mimicry.

We suggest further research is needed into the networks of farmers participating in extension activities to gain insight into the effect of verbal communication within farmer networks. Finally, further exploration of external motivations related to 'social licence to operate' should be investigated, as these motivations may be increasingly important drivers for the adoption of pro-environmental practices within countries with light-touch regulation.

4.7 Acknowledgements

We are grateful to all the farmers who participated in our interviews. We also thank our colleagues Paul Edwards, Callum Eastwood and James Turner for providing useful suggestions and ideas during the research. We thank the programme Forages for Reduced Nitrate Leaching, with principal funding from the New Zealand Ministry of Business, Innovation and Employment and co-funding from research partners DairyNZ, AgResearch, Plant & Food Research, Lincoln University, the Foundation for Arable Research and Manaaki Whenua – Landcare Research. This work was also partially supported by the Rural & Environment Science & Analytical Services Division of the Scottish Government.

5. Paper 4: Reshaping a farming culture through participatory extension: An institutional logics perspective

5.1 Abstract

Historically the dominant farming culture in Western developed countries, such as Scotland and New Zealand, has been based on maximising food production and maintaining the family business. However, this culture of production and family is under pressure from societal calls to increase the uptake of environmental practices in farm management. The pressure is leading farmers to adopt environmental practices, which causes a clash with the beliefs and values underlying the culture of production and family business. This clash is problematic, as it might form a barrier to sustained environmental change, for which not only practice change is required, but also a change in beliefs and values guiding the farming culture. This study explores the clash using an institutional perspective to: i) analyse how farmer practices, beliefs and values change due to external pressure to adopt environmental practices; ii) identify mechanisms via which this change unfolds; and iii) understand the role of participatory extension initiatives in this change. An institutional perspective enables this study to move beyond attitudes, behaviours, and adoption of environmental practices, towards considering how farmers' practices, beliefs and values together constitute the culture of farming. Twenty Scottish and 52 New Zealand farmers participated in qualitative, open-ended interviews and were observed during discussion groups or advisory meetings. Our findings show that all farmers are guided by a 'business', 'lifestyle' and/or 'learning' logic. The institutional clash influenced practices underlying the business logic to change from being purely based on maximising productivity, to including environmental aspects. However, no change in values was observed. Participatory extension initiatives influenced practices, beliefs and values underlying the learning logic (changing from a 'linear' to 'multi-actor' logic) and thus can help facilitate more effective change by providing support via micro-mechanisms and enabling dynamics. The study contributes to current literature by introducing a new lens for understanding change induced by participatory extension programmes and by providing change agents, such as extensionists, with more in-depth knowledge about the main logics guiding the culture of farming, and the mechanisms by which

farmer practices, beliefs and values may change. This will help to communicate, frame and organise extension initiatives.

Keywords: institutional logics, institutional change, bottom-up processes, participatory extension, discussion groups, practice change

5.2 Introduction

Two major challenges the Scotland and New Zealand agricultural sector are facing are climate change and water pollution due to emissions from on-farm activities (De Klein and Ledgard, 2005; IPCC, 2014). In response, communities, scientists, policy-makers and industries are asking for change via societal calls to improve environmental practices in farm management. Farmers are, therefore, under increasing pressure to adopt environmental practices aligned with 'external' societal and political expectations of good farming (Hart, 2017; Legett, 2017). For sustained environmental change, not only practice adoption, but also a change in beliefs and values is required (Burton, 2004a; McGuire et al., 2013). Historically the dominant farming culture in Scotland and New Zealand, from here on referred to as 'farming culture', has been based on the beliefs and values of maximising food production and maintaining the family business. The pressure from societal calls to improve environmental practices in farm management leads to an institutional clash within the farming culture, in which the requirement to adopt environmental farming practices does not align with the beliefs and values of maximised productivity and family business.

To improve farm environmental management, policies (e.g., regulatory frameworks, market-based instruments, research and extension programmes) have been applied (Greiner and Gregg, 2011; Lockie, 2013). However, designing successful policy to achieve change is challenging due to the biophysical, economic and social heterogeneity of the agricultural sector (Darnhofer et al., 2012b). To address this heterogeneity, there is an increased emphasis on designing policy in which farmers and technical experts are included, such as participatory research and extension programmes (PEPs) (P. Brown et al., 2016; Knook et al., 2018; Vrain and Lovett, 2016). In PEPs, farmers are participants in knowledge generation and practice change via experimentation on farm, and by demonstrating and scrutinising practices in discussion groups with peers, experts

and researchers (Cristóvão et al., 2012; Scoones and Thompson, 2009). These PEPs aim to increase farmer resilience to environmental challenges by embedding new practices within the farming culture (Burton and Paragahawewa, 2011; McGuire et al., 2013). Previous research shows that PEPs are recognised for achieving practice change (e.g. Goodhue et al., 2010; Läpple et al., 2013; Läpple and Hennessy, 2015; Tamini, 2011), but there are concerns that while PEPs successfully lead to practice adoption, they may not lead to sustained change, because of not changing beliefs and values required to embed new practices in the farming culture (Sewell et al., 2017). This suggests that there is a need for increased understanding of the mechanisms by which PEPs can not only change practices, but also reshape beliefs and values.

To increase understanding into the institutional clash within farming culture, and the role of PEPs in this clash, an institutional perspective can be applied. Institutions are 'the more-or-less taken-for-granted repetitive social behaviours, which give meaning to social exchange and enable self-reproducing social order' (Greenwood et al., 2008 p. 5). Farming culture is such an institution, consisting of practices, beliefs and values that constitute 'good farming' (McGuire et al., 2013). Institutional theory highlights the importance of a shift in values, beliefs and practices (so called institutional logics) to achieve culture change. Institutional logics are 'the socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, and beliefs, by which individuals and organisations provide meaning to their daily activity, organise time and space, and reproduce their lives and experiences' (Thornton et al., 2012 p. 2). There is interest in understanding mechanisms, which are the processes contributing to and eventually leading to the unfolding of a change in logics (Micelotta et al., 2017; Smets et al., 2012). Institutional studies also acknowledge the lack of understanding into how an institutional clash at practice-level can lead to a change in beliefs and values (Smets et al., 2012). There have been calls for research accounting for these aspects when studying farmer change (Burton, 2004b; Inman et al., 2018), but few studies explore what mechanisms, including PEPs, may successfully stimulate changes in values and beliefs underpinning environmental practices in agriculture (Burton, 2004a; McGuire et al., 2013).

To address this gap, we study change in farming culture after an institutional clash and identify change mechanisms, including how PEPs stimulate institutional change via practice change and learning. Thus, our study moves beyond a focus on attitudes, behaviours, and adoption of

environmental practices (e.g. Baumgart-Getz et al., 2012; Pannell et al., 2006), to study change by considering the practices, beliefs and values that constitute farming culture. Four questions address this aim: i) what are the dominant logics (practices, beliefs and values) that constitute farming culture in NZ and Scotland?; ii) have these logics changed in the last decade due to external expectations?; iii) what mechanisms have influenced this change?; and iv) how have PEPs contributed to this change?

The following sections provide an overview of the dominant farming culture in Scotland and NZ, followed by an overview of the conceptual framework. Subsequently, methods are described, including case study areas, findings presented and discussed, and theoretical and practical implications provided.

5.3 The culture of farming in Scotland and New Zealand

Scotland has been part of the United Kingdom (UK) since 1707 and has therefore largely been subjected to UK policy. Although our study sample consists of Scottish farmers, in this section we focus on the UK as a whole to explain the historical development of the Scottish farming culture.

Up until the 1970s the main objective of NZ agriculture was helping feed the UK during industrialisation and World War I and II (Brooking and Pawson, 2010; Rosin, 2013). This stimulated a strong productivist mentality amongst farmers, in which the focus was on maximising food production through intensive production approaches (Burton, 2004a; Burton and Wilson, 2006; Haggerty et al., 2009; Wilson, 2001). Such a productivist mentality was expressed in for example the value of 'tidy' looking fields, which was believed to be achieved by good crop appearance, leading to the practices of high fertiliser use and mono-cropping (Burton, 2004a). The culture aimed at maximising food production was valued by not only farmers, but by the whole nation of NZ and the UK, who saw the agricultural sector as the backbone of NZ's economy and essential in the economic position of the UK (Hunt et al., 2013).

From the 1970s onward, the dependence of the UK on NZ changed. The UK became a member of the European Union (EU) in 1973 and adopted its Common Agricultural Policy (CAP). This led the UK to become self-sufficient on an EU-level by paying farmers for their produce and providing them with guaranteed markets. Due to the decreased food demand, NZ experienced several

crises leading to a significant decrease in government support (Gouin, 2006), such as the removal of farm subsidies in 1982/83. At the same time changes were made to the CAP in the UK. Farmers had been stimulated to maximise on-farm production, but negative environmental effects, such as water pollution and soil impoverishment, started to emerge (Delayen, 2007). This led to CAP reforms in which a small subset of subsidies were moved away from enhancing food production (Hanley et al., 1999), which caused UK farmers to develop a stronger economic focus. Similarly, the removal of subsidies in NZ also led to a stronger economic focus. In both countries a 'business farmer' identity, which refers to farmers who take up practices to maximise profit instead of to maximise production, was stimulated (Burton and Wilson, 2006).

Due to the historical emphasis on maximum productivity and the development of the business mentality the shift towards a more environmentally friendly farming culture has been challenging during the last two decades. One of the issues is that the values and beliefs of the business and productivist culture do not align with the practices of an environmentalist culture. For example, mono-cropping has long been regarded as the most productive and profitable practice. However, from an environmental perspective the practice of poly cropping would be preferred. The value of running a profitable business is believed to be achieved by mono-cropping and not by the practice of poly-cropping. This practice thus clashes with 'good farming' beliefs and values (Egoz et al., 2001). Farmers have therefore tended to be interested in the uptake of environmental farm measures that demonstrate business success, and thus align with their business values and beliefs, rather than less tangible signs of 'environmental farming' such as planting buffer strips (Burton et al., 2008; Collins et al., 2016). Hence, farmers have been less likely to adopt new practices if these do not align with their dominant values and beliefs about 'good farming' (Burton, 2004a; Inman et al., 2018; McGuire et al., 2013).

Besides a focus on productivity and profitability, most farms focus on family, because many farms are currently still family businesses and have an ambition to hand over their business to the next generation. They have therefore been likely to take decisions that benefit the farm long-term. This has led farmers to, for example, increase the size of their farm or convert their business to a more profitable form of farming (Copland and Stevens, 2012). Sutherland (2010) showed that farmers are more likely to comply with environmental legislation if this improves long-term farm viability.

The overview of farming culture and change shows that, when aiming for successful change, it is important to consider how well new practices and beliefs fit into the dominant farming culture of business and family (Burton, 2004a; Inman et al., 2018; McGuire et al., 2013).

5.4 Conceptual framework

This section presents institutional logics that view farming culture as an interaction between the implementation of practices and rules, the expression of beliefs, and the presence of values. We will study institutional logics through their expression in language and practice (Thornton et al., 2012). This provides insight into the dominant logics underlying farming culture. We then look at how an institutional logics perspective can be used to understand change in farming culture due to the uptake of new practices, and the mechanisms by which this change unfolds.

5.4.1 Institutional logics

The majority of the literature on institutional change has focused on sudden and large changes on a field-level, i.e. a whole sector (Micelotta et al., 2017). It is, however, acknowledged that institutional change can also start at an individual-level and diffuse slowly (Thornton and Ocasio, 2018). For example, practice-level change, which begins with organisational practice change, leads to an institutional change by initiating changes in beliefs and values, and practices then diffuse to other organisations and eventually to field-level (Smets et al., 2012).

From an institutional logic perspective practice change is initially driven by an institutional clash (when multiple incompatible practices, beliefs and values exist). To ensure ongoing functioning of an organisation, this clash must be overcome by a change in logics, which means not only a change in practices, but also in the beliefs and values. Many farmers in NZ and Scotland are currently experiencing an institutional clash. There are external expectations regarding environmental farming practices, leading farmers to adopt environmental practices, but current 'good farming' values and beliefs are in conflict with these environmental practices. This study seeks to understand how this clash unfolds at an individual-level, and how this may reshape the logics regarding 'good farming' at an individual and field-level.

5.4.2 Mechanisms contributing to a change in institutional logics

Mechanisms of institutional change help to understand how farming culture is being reshaped by the institutional clash. Previous studies (e.g. Gray et al., 2015; Smets et al., 2012) have identified mechanisms contributing to institutional change, which informed this study's conceptual framework (Fig. 10).

5.4.2.1 Micro-mechanisms

Five micro-mechanisms occur at an individual-level. The first, *situated improvising*, happens immediately after the clash when farmers enter an experimental learning stage (Lounsbury and Crumley, 2007) to develop new practices (Orlikowski, 1996). *Network reorientation* and *elaboration* then support *situated improvising* by bringing together different and more actors (e.g. researchers) to support development of the new practices. This enables knowledge exchange around how and which practices can be implemented (Getz and Warner, 2006; Greenwood et al., 2011), helps assessing the extent to which the practices address the clash, and exposes farmers to actors with different beliefs and values. Wood et al. (2014) show that farmers who participated in a PEP significantly grew the networks through which they acquired new knowledge (*network elaboration*). Enabling farmers to be active knowledge contributors also encourages *network reorientation* (Coutts, 2005; Vereijssen et al., 2017). *Double loop learning* can occur from the trust developed through sustained knowledge exchange with peers, experts and researchers (Franz et al. 2010; Rao, Monin and Durand 2003; Sewell et al. 2014; Sherson et al. 2002; Röling 2009). Via feedback loops, this learning changes frames of reference and subsequently reshapes beliefs and assumptions (Argyris and Schon, 1996; Inman et al., 2018). A fifth micro-mechanism, *emotional intensification* (Gray et al., 2015), occurs by creating an emotional connection among actors when focusing on the same activity, for example when researchers and farmers work through a problem together by discussing experiments and solutions. This also supports the development of a new shared set of beliefs and values (Gray et al., 2015).

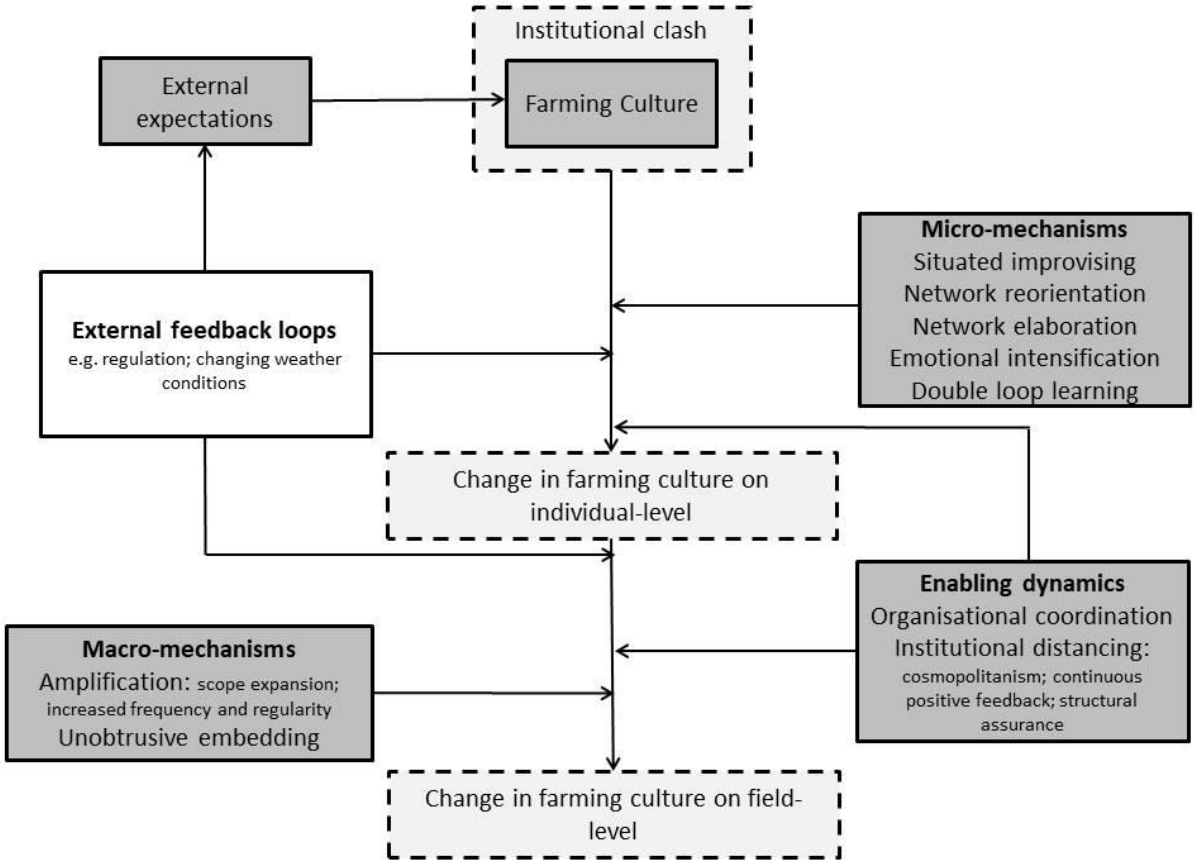

Figure 10: An overview of mechanisms of change in farming culture. External expectations push for the implementation of environmental practices, which leads to a clash within current practices, beliefs and values of the farming culture. Mechanisms of change (in dark grey boxes), assisted by external feedback loops (in white box), contribute to a change in farming culture on an individual-level. Subsequently, new practices, beliefs and values can move up to a field-level through amplification and unobtrusive embedding.

5.4.2.2 Macro-mechanisms

The process by which practices become taken for granted, so thereby reshaping the frame of reference and redefining beliefs and values, is known as *amplification* (Gray et al., 2015). This is essential for practices to radiate to the field-level, i.e. how new practices and associated beliefs and values radiate to more farms. After *emotional intensification* on an individual-level, *amplification* is achieved by two macro-mechanisms: i) *scope expansion* through adoption of new practices by a broader group of people, who in turn might be connected to other groups; and ii) increased *regularity and frequency* of a new practice and its terminology due to repetition of

practices in stable networks. The new practices, and associated beliefs and values, then become institutionalised. Another macro-mechanism, *unobtrusive embedding,* explains the diffusion of the practice to a field-level by a bottom-up approach with active engagement of actors in the practice itself. The bottom-up approach may make the new practice difficult to resist compared to practices imposed top-down (Quack, 2007). Agricultural practice change literature shows that, via exposure to new actors and ideas (e.g. demonstration farmers showing environmental practices), adoption is more likely to occur by other farmers in their social network (Pannell et al., 2006; Small et al., 2016).

5.4.2.3 Enabling dynamics

To achieve successful change on an individual- and field-level, Smets et al. (2012) highlight enabling dynamics in addition to micro- and macro-mechanisms of change. The first enabling dynamic is *organisational coordination*, which follows *situated improvising* by formalising the practices and outcomes from that improvisation. These clarified practices and outcomes can be diffused to other actors. A second enabling mechanism is *institutional distancing,* which aims to weaken actors' commitment to existing logics that clash with the new logic, via three sub-mechanisms: *cosmopolitanism,* which is the inclusion of actors who are not part of the usual beliefs embedded in existing logics; *continuous positive feedback,* which refers to receiving constant positive messages from peers and experts that the new practices are working; and *structural assurance*, which refers to providing change actors with enough space to accept new logics and thereby minimising the pressure to maintain the dominant logics of the current culture.

5.4.2.4 External feedback loops

In addition to the internal mechanisms of change, *external feedback loops* are required (Beers et al., 2014; Klerkx et al., 2010). McGuire et al. (2013) highlight that farmers are subject to change due to the pressure of incoming regulation or observing changing climatic conditions, such as prolonged rainfall, which stimulates a need to address environmental issues to make their farm more resilient to future change. These external feedback loops can also feed back into external pressures contributing to the initial clash. For example in New Zealand, observed changes in

water quality have led community and local stakeholders to question current farm management practices (Legett, 2017).

5.5 Methods

5.5.1 Study area

Scotland and NZ were selected as study areas, because both countries: i) faced environmental challenges in the agricultural sector (IPCC, 2014; Roy, 2019); ii) had similar economic prosperity; and iii) relied on voluntary initiatives to achieve on-farm change (for climate change in Scotland and water quality in NZ). However, there was also an important difference between the two countries: the NZ context, characterised by an unsubsidised *laissez-faire* approach, mostly relied on industry bodies to develop extension initiatives (e.g. DairyNZ, 2017); Scottish farmers faced most change via regulation, supported by other policies such as marked-based approaches and voluntary extension programmes, of which the latter were developed and funded by the Government (The Scottish Government, 2017). Being able to consider the influence of two different socio-political contexts has potential relevance for countries facing changes regarding their agricultural policy, such as post-Brexit policy in the United Kingdom.

5.5.1.1 Scotland

The selected group of respondents were located in different parts of Scotland and had all participated in a PEP focused on stimulating the uptake of no-cost climate change mitigation measures: practices that reduce emissions while maintaining (and in some circumstances increasing) farm profits. The Scotland PEP consisted of monitor farms where discussion group meetings were hosted once every two months over three years, to discuss the implementation of (scientifically proven) practices on farm. Participation in the discussion groups was voluntary and groups consisted of 10 to 30 farmers. The meetings included multiple ways of information dissemination: experts were invited to present new information to farmers, farmers were invited to attend a demonstration site of the focus farm, and facilitators moderated a group discussion. Learning in the discussion group was undertaken on a farmer-to-farmer level, as well as between farmers, experts and facilitators. The 20 interviewees (Sc PEP farmers) were part of the

discussion groups, but not all engaged to the same extent: 10 farmers attended more than 3 meetings and the others 2-3 meetings.

5.5.1.2 New Zealand

The NZ participants were all located in Canterbury, a province in the South Island. Of the 52 farmers, 12 participated in a PEP (NZ PEP farmers), 18 were part of the informal network of the PEP farmers (network farmers) and 22 were not involved with the programme at all (NZ farmers).

The NZ PEP was a participatory research and extension initiative around nitrate leaching. The programme started in 2013 and aimed to reduce nitrate leaching from dairy, arable, and sheep and beef farming by 20% (DairyNZ, 2017) by applying a participatory research and extension approach to maximise the uptake and development of beneficial forage practices, such as mixed-species pastures, crops with low nitrogen content and catch crops (Edwards et al., 2015). Researchers, extension agents and nine monitor farms in Canterbury, consisting of four dairy farms, two arable farms, two sheep and beef farms, and one mixed arable and dairy farm, participated. The NZ PEP applied an experimental approach, in which researchers, experts and farmers discussed what practices would be suitable on-farm and consequently experimented with these practices. The PEP did not organise regular discussion meetings, but participants were strongly embedded in their personal networks. To gain insight into the diffusion of practices, beliefs, and values, the farmers in the network of participants were included in our analysis.

5.5.2 Data sources

To ensure a rich accumulation of data to draw inferences from, we aimed to obtain information from multiple resources, including in-depth interviews and participant observations. The first author conducted interviews and participant observations from May 2017 until December 2018.

5.5.2.1 Interviews

Seventy-two face-to-face interviews were conducted: 52 with NZ farmers (Appendix D, Table 13) and 20 with Scottish farmers (Appendix D, Table 14). Each interview lasted 1 to 3 hours, was audio-recorded and completely transcribed. The method of oral history interviewing was used,

in which the interviewee was asked to reflect upon a specific period in the past (Bryman, 2012) to gain insight into the logics of farming, how these changed during the last 5 to 10 years and what caused them to change. If the respondent mentioned any changes, a follow-up question was asked to elaborate on the motivation for this change. Hence, follow-up questions depended on their response and emerged based on the changes they had made. To gain insight into how the PEP contributed to a possible change, NZ and Sc PEP farmers were asked extra questions regarding the changes they had made due to PEP participation.

5.5.2.2 Observations

Before conducting the interviews, discussion group and farmer-advisor meetings were observed. These observations were conducted to focus on individual actors, which provided detailed insight into their work (Jarzabkowski et al., 2009; Kellogg, 2009). Although these observations were not coded, they were instrumental in providing the farming context in both Scotland and NZ and in developing the conceptual model.

5.5.3 Data analysis

An inductive methodology was used to identify the logics in farming culture. Subsequently, the conceptual framework described in this paper was used to identify the mechanisms by which these logics had changed (Yin, 2013). Based on the conceptual framework and the data we suggested a new framework to describe how participation in a PEP could contribute to change in farmers' practices, beliefs and values. The interviews and observations were analysed using NVivo 12 (QSR International Pty Ltd, 2018).

5.6 Findings

Findings show the Scottish and NZ farming culture is guided by multiple logics: *business, farming lifestyle, family,* and *learning*. The *farming life* and *family* logics did not change due to the institutional clash, whereas the *business* logic did. Due to PEP participation the *learning* logic moved from a *linear learning* towards a *multi-actor learning* logic. Although the overarching

logics were the same, differences in specific beliefs and practices were visible between Scottish and NZ farmers.

We will first elaborate on the institutional clash, before describing each of the logics derived from the interviews and observations (Table 5). Subsequently we will explain the mechanisms of change and how PEPs contribute to this change (Fig. 11).

5.6.1 The institutional clash

External expectations regarding the uptake of environmental practices have put farmers in a position in which they need to change, but this has caused a clash within their current logics. Thus, farmers have struggled to align the need for practice change to their current farming beliefs and values, as evidenced by the following quote:

"Well most of the [agri-environmental] schemes involve taking land out of production, to set it aside, or to change it. For the size of farm that we have, I think we need every bit of land possible. It doesn't really fit the system. And we are not an extensive farm, we are quite small, so we have to be quite intensive. So taking land out of production does not fit that ethos.' – Scottish interviewee 18

Furthermore, although farmers acknowledged environmental practices to be important, the majority of farmers still described good farming according to a production-focused business logic:

"We want it to be a profitable farm, tidy farm. We like things to look good – tidy [..], well organised. [..] Things are kept well and the grazing is done well and the animals looked after well, the staff looked after well. Just a well-organised and a tidy looking farm, yeah." – NZ interviewee 5 PEP farmer

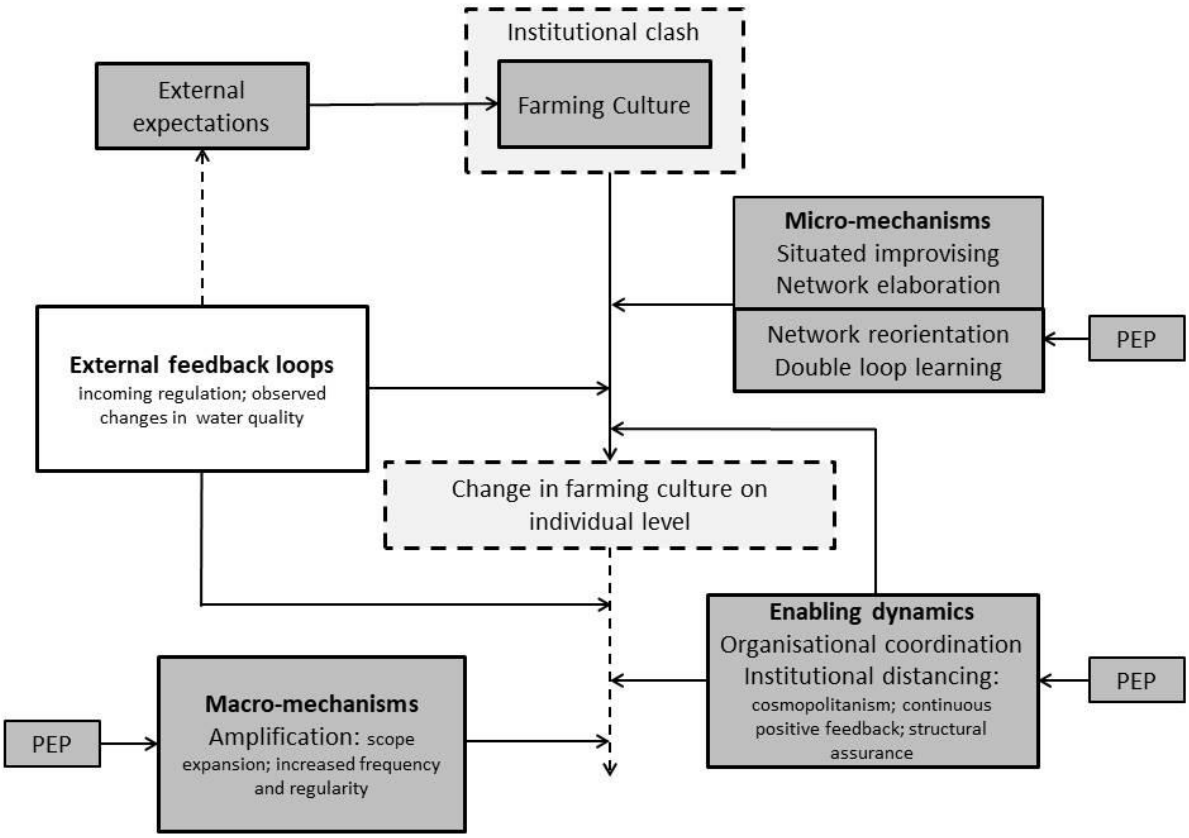

Figure 11: Overview of the institutional clash and which mechanisms lead to a change in institutional logics. Only a change on an individual-level is depicted, because no change on a field-level was observed. PEPs did however attempt to implement mechanisms to ensure amplification, but this did not result in change on a field-level.

5.6.2 The development of the logics of farming

Farmers adhered to multiple logics, of which the *farming life, family* and *business* logics were expressed by all farmers. While the *farming life* and *family* logics did not change due to the institutional clash, the beliefs and practices underlying the *business* logic did change, and the *learning* logic changed completely due to PEP participation. The logics and how they were expressed are described in Table 5.

Table 5. Multiple logics present in Scotland and NZ, explained by values, beliefs/assumptions and rules/material practices.

Business logic (adhered to by Scotland farmers, NZ PEP farmers, NZ network farmers, NZ non-PEP farmers)	
Values	Farm profit-oriented goals
Beliefs/assumptions	Entrepreneurship, animal welfare, land care, employee well-being and efficient production is essential to keep the business running in the future; ease of running the farm is important to keep the workload low; being aware of subsidy policy is essential in optimising farm management and finances; and taking into account the 'public eye' is important to maintain legitimacy to farm.
Rules/practices	Implementation of 'win-win' measures that have multiple benefits, e.g. economic and environmental; diversification into a new branch of business; self-sufficient in energy supply; minimise staff hire; manage farm to optimise subsidy use; minimise business expenses by e.g. in-house vehicle repair; owner takes strategic role to manage the business; and tidy looking farm.
Farming lifestyle logic (adhered to by a subset of Scotland farmers, NZ PEP farmers, NZ network farmers, NZ non-PEP farmers)	
Values	Farming lifestyle and allowing continuation of farming lifestyle before retirement.
Beliefs/assumptions	Maintaining farm lifestyle for own ambitions.
Rules/practices	Simplify practices and minimise changes to allow staying on the farm if possible.
Family logic (adhered to by a subset of Scotland farmers, NZ PEP farmers, NZ network farmers, NZ non-PEP farmers)	
Values	Providing future family opportunities and family cohesion.
Beliefs/assumptions	Duty to provide the next generation with the option to continue farming.
Rules/practices	Diversification of income; expansion of the farm for enough work; traditionalism (continue practices of previous generations as sign of respect or because this has always worked in past); and carry on business to keep options open; focus on long term gain.
Linear learning logic (adhered to by Scotland farmers, NZ network farmers, NZ non-PEP farmers)	
Values	Information collection to stay up-to-date with recent developments and regulations.
Beliefs/assumptions	Experts and researchers develop regulation and guidelines, farmers are to adapt their on-farm management based on the regulation and guidelines.
Rules/practices	Attending information meetings; become a member of local committees, such as irrigation committees.
Multi-stakeholder learning logic (adhered to by NZ PEP farmers)	
Values	Multi-stakeholder learning and information exchange; integrating knowledge of experts, researchers and farmers to create successful on-the-ground solutions.
Beliefs/assumptions	More openness to change by farmers due to increased understanding that knowledge leads to better farm management; better aligned research due to researchers' understanding of the farm leads to more benefits of research for farm.
Rules/practices	Direct knowledge exchange between farmers and researchers; and facilitation of knowledge exchange meetings.

5.6.2.1 No clash: Farming life and family logic

All farmers expressed either the *farming life* or *family* logic. The *farming life* logic is about maintaining a lifestyle on-farm, in which farmers did not focus on succession, but valued their life on the farm and wanted to stay there if possible. This value was expressed in similar beliefs by farmers in Scotland and NZ, such as simplifying on-farm labour by the practice of contracting out work to make work less labour intensive:

"I have a year or ten before I can retire and before I probably want to. I suppose some of the decisions we are making within the practicality of the farming, is that we are making things simpler. So it's less labour intensive, and easier to accomplish." – Scottish interviewee 2

In the *family* logic, succession and offering the family the farming lifestyle were important. This logic was expressed by farmers who valued succession or family living on the farm. Farmers with the *family* logic believed long-term decision-making is essential. Practices included the purchase of more land and the conversion to a different type of farming:

"*I think we will try and stay here for a while, or that's the plan, because I also have a younger brother who is going to come home and farm. And the farm in Ashburton was not big enough for the both of us. So we bought this with the idea that it is big enough for both me and him."* – NZ interviewee 20 Network PEP

5.6.2.2 Changing practices and beliefs: Business logic

All farmers expressed a *business* logic, which mostly consisted of the value of a profitable farm. Farmers indicated they achieved this by maximising productivity, but the external pressures for environmental practice change has led to the belief that a profitable farm is achieved by 'ticking the boxes'. This means that the focus moved from productivity only to including complying with environmental regulation, health and safety, etc.:

"Animal welfare, environment, those are the things that should be a box that we are able to tick to show what we are doing. Especially if you look at the future of NZ as a premium food producer, if that is the goal, we have to tick those boxes, it's part of our business." – NZ non-PEP interviewee 52

This change was illustrated by the practice of farm conversion in Canterbury. Converting from beef and sheep farming to dairy farming (in areas where water was available for irrigation) increased farm productivity and was a step towards more profitability. However, the conversions to dairy farming have caused Canterbury to struggle with larger environmental impacts. Due to external pressure farmers have realised that running a profitable business does no longer entail a sole focus on productivity, but also on labour and resources:

"*Just being efficient in terms of labour, resources, products and that also flows on productivity and profitability. So that all just ties in [..] That would be one major change, yes now more about efficient production instead of maximum production."* – NZ PEP interviewee 1

NZ and Scottish farmers coped differently with the institutional clash. Due to low regulation farmers in NZ were sensitive to 'the public eye', which led to the belief that to run a good business it is in practice necessary to tick the environmental boxes to an extent that satisfies the public:

"Well as I say, it influences really in terms of like – as I say, if we're going to have these lovely native plants along our roadside, we're going to do it here where the public are, rather than doing it somewhere no one goes." – NZ non-PEP interviewee 38

Farmers in Scotland were embedded within a subsidised farming system, which led to the overall belief that changes towards the environment should only be made when subsidised. Hence, due to the different socio-economic context, NZ and Scotland farmers adhered to the same value of running a profitable business, but had different beliefs and practices of how to achieve that value:

"*But obviously we are manipulating the [subsidy] system to suit our activities, at least to a point. I mean now we don't have to do greening. I have 75% in grass, so I am allowed a 100 acres of green, without having greening and setting aside*." – Scottish interviewee 1

Overall, Scottish and NZ farmers experienced the institutional clash and are including environmental practices in their business logic. However, farmers did not adopt environmental practices because environmentally friendly farm management has become a value of their farming culture, but because it is needed to maintain a profitable business.

5.6.2.3 Development of a new logic: The multi-actor learning logic

All farmers adhered to a third logic, the *learning* logic, though it differed between NZ PEP farmers and other farmers. NZ PEP farmers developed a *multi-stakeholder learning* logic, whereas other farmers expressed a *linear learning* logic. While monitor farmers believed in optimal learning by the inclusion of multiple actors for knowledge acquisition, other farmers did not mention developing new beliefs around obtaining information. The development of new values, beliefs and practices by PEP farmers developed due to the direct and frequent engagement with multiple stakeholders during the duration of the PEP. The farmers expressing the *multi-stakeholder learning* logic valued the integration of expert-based knowledge to be able to create context-based solutions. Through the practice of multi-stakeholder meetings and discussions of new practices, knowledge was successfully exchanged between multiple stakeholders:

"It has been good meeting them and getting to know them, so in the end if I have questions I can go straight to them, with questions about anything. And likewise, if these researchers have an idea and they could potentially come straight to me to see if I think it would work, or if I want to participate or things like that." – NZ PEP interviewee 4

5.6.3 Mechanisms of change

NZ and Scottish farmers have changed the practices and beliefs underlying the business logic, but maintained the primary value: running a profitable business. The beliefs to achieve profit shifted from a sole productivity focus to more holistic management, including environmental compliance. The change in beliefs and practices originated on a practice-level via *situated improvising*. When farmers were faced with having to reduce their emissions, they started experimenting. For example, one NZ farmer experimented with practices to reduce emissions (before participation in the PEP):

"I think two years ago we removed about 15 per cent of the herd or something. Then we produced 1 per cent less milk or so per season. So the cows were a lot less efficient before. We cut the amount of supplements by half compared to what they were the year before. And then the ground, it has allowed us to do more regrassing. So we are growing more grass using a similar amount of nitrogen. The aim is actually to, this year hopefully, reduce this nitrogen." – NZ PEP interviewee 1

Network elaboration occurred after *situated improvising.* Some farmers, for example, became involved in irrigation committees or attended meetings hosted by policy-makers, to keep up to date with environmental developments. *Network elaboration* did not change their values, but did change their beliefs and practices underlying a profitable farm by complying with environmental regulation.

"[Being a member of an irrigation committee] provides you with a wider perspective of what is going on and it also keeps you up to date with the wider picture of what is happening regarding the wider community here in terms of nutrient and environmental issues. I think it is [important], yes [..] If you want to be farming nowadays you have to look further than just inside your farm boundaries." – NZ non-PEP interviewee 43

5.6.3.1 Mechanisms of change due to PEPs

PEPs specifically enabled *network reorientation.* Before participation in the PEPs, farmers were not used to direct interaction with researchers and technical experts; besides visits by farm advisors. The NZ PEP organised at least one meeting per year, inviting all actors involved in the PEP to discuss findings. These meetings were attended by approximately 30 people, from industry, research and farming. *Double loop learning* occurred due to the regular meetings with all actors, the long-term interaction between researchers and farmers, and the opportunity to conduct and discuss an experiment, such as the implementation of new crops to reduce nitrate leaching. This led farmers to redefine their beliefs and values on knowledge acquisition. Instead of being knowledge consumers, they became knowledge constructors. The combination of *double loop learning* and *network reorientation*, in addition to *situated improvising* and *network elaboration,* led NZ PEP farmers to become *multi-actor learners.*

Double loop learning and *network reorientation* only led to a change on an individual-level, whereas we did not observe changes on a field-level. Due to the interaction of PEP farmers with non-PEP farmers, for example at other farmer events or in the pub, we expected to observe *unobtrusive embedding*: farmers would informally discuss the success of their new approach to farming, which would then be adopted by a wider farmer group. However, farmers in the network of the NZ PEP farmers highlighted the difficulty of accepting new farming practices:

"There is a lot of stuff that came out from the [monitor] farm about fodder beet and the environment, the less emissions as well and all that kind of carry-on. It's just crap I am afraid to say. I totally disagree with it, because the statistics are downright lies. It's because it's not looking at the whole picture, it's looking at a small block in time. And not the big picture. Like the environment is about the big picture, it's not about this bit, and this bit and this bit. It's all about this bit. And it's just statistics and downright lies." – NZ network PEP interviewee 12

The same was observed for Scottish discussion group farmers, who had a sentiment that the monitor farmers who hosted the discussion groups did not always fully understand the practice changes that were discussed or demonstrated on the farm. Therefore, the monitor farmers did not have credibility and thus the discussion group farmers had difficulty adopting new practices, beliefs and values.

"I don't know if [the monitor farmer] fully grasps everything that all these cover crops can do either. There are people who were at the meetings who were more on board, or more embracing these things than maybe [the monitor farmer] was, so I probably learned more speaking to these guys, rather than actually than any presentation or listening what [the monitor farmer] was doing." – Scottish interviewee 3

A mechanism to ensure dissemination to a field-level was *amplification*, requiring *emotional intensification* on an individual-level, followed by *scope expansion* and *increased frequency and regularity* to ensure dissemination to a macro-level. *Emotional intensification* was not observed in either of the PEPs. *Increased frequency and regularity* was observed in the New Zealand PEP. Participants in the PEP selected three nitrate leaching reduction practices to focus on in the initial stages of the programme and consistently framed messages to ensure adoption (and knowledge) of these practices on a field-level. These practices were framed as low-cost options to reduce nitrate leaching. Farmers outside the PEP, including farmers outside the network of PEP farmers, were aware of the three practices. The Scotland PEP did not use the mechanism of *increased frequency and regularity,* but used *scope expansion*, by hosting discussion groups on monitor farms.

The PEP also provided enabling dynamics. The NZ PEP provided *organisational coordination* by coordinating and pulling together a set of the PEP outcomes after the farmers independently conducted *situated improvising*. For example, the NZ PEP was a 6-year programme, which started off in the first years exploring options to reduce nitrate leaching

on farm. Three low-cost practices were then selected for the programme focus. By supporting and formalising these practices and outcomes legitimacy was gained with other farmers by fitting with existing institutional logics. Not all aspects of a second enabling dynamic, *institutional distancing*, were observed in the NZ PEP. *Continuous positive feedback* was given by the PEP coordinator. During the first meeting there were no seating arrangements, which resulted in the researchers and industry partners clustering together in the front of the room and the farmers doing the same at the back of the room. Observing a similar meeting four years on, farmers and researchers felt comfortable sitting at the same table and discussing case studies to enable solutions to on-farm challenges. The PEP coordinator changed this by showing previous successes achieved by having multi-actor communication. This led actors (including farmers) to believe in the success of these types of programmes. *Cosmopolitanism* was partially observed. A number of the experts involved in the PEP were already rural experts, who were very aware of on-farm constraints. A smaller group of people came in with a completely new way of thinking, which is essential in supporting change. The third aspect, *structural assurance* was partially provided on an individual-level in the NZ PEP. For example, a number of farmers received labour assistance by planting new crops to reduce nitrate leaching. This provided them legitimacy and space to implement a new practice from a financial perspective. However, how farmers respond to pressure from peers, due to implementation of practices that do not fit with dominant logics, was not addressed in the programme.

5.6.3.2 External feedback loops

The NZ farmers who participated in our research were all, to differing extent, faced with incoming nitrate leaching regulation. This functioned as an external feedback loop, because NZ farmers in this study were concerned about being subjected to regulatory enforcement, which motivated them to explore ways to reduce nitrate leaching.

"It's going to take three years for it to be recognised by Overseer[3]*. Farmers aren't going to put [environmental practices] in until we see some benefits in Overseer from putting it in because it is a cost."*

[3] Overseer is software developed to support on-farm nutrient management decisions. Overseer is also used by Regional Councils to estimate on-farm nitrate leaching from farm practices. This

The external feedback loops also influenced external pressures. Although farmers often did not observe changes on farm, the local community did. This then strengthened the external pressure further contributing to the institutional clash.

5.7 Discussion

This paper studied the institutional logics Scottish and NZ farmers hold regarding farming, and the mechanisms (including the role of PEPs) by which these logics changed when farmers faced an institutional clash. To achieve this aim we looked at the development of logics during the last decade, we described the dominant logics currently guiding farming culture in NZ and Scotland, and explored change mechanisms.

The findings show that farmers have been guided by *farming life* and *family* logics, and this has not changed as a result of the institutional clash. As a response to the institutional clash, and supported by the PEP, changes were observed in the *business* and *learning* logics. The practices and beliefs guiding the *business* logic changed but are still steered by the main value of 'running a profitable business'. The *learning* logic changed from a *linear* logic towards a *multi-actor* logic, but only for PEP farmers.

In the following discussion we will firstly discuss the mechanisms underlying the observed change in logics. Then the theoretical implications are discussed and compared with earlier research. Lastly, the practical implications are presented, providing recommendations for PEP and evaluation design.

5.7.1 Core mechanisms of change

Our findings highlight the importance of multiple and complementary mechanisms to establish change on an individual-level and to amplify to a field-level. Four out of five change mechanisms were identified at an individual-level: s*ituated improvising, network elaboration, double loop learning* and *network reorientation*. The latter two were specifically stimulated by PEPs. Although *emotional intensification* was not observed, the combination of the other four mechanisms stimulated a change in NZ PEP farmers' learning logic towards becoming *multi-actor learners.* Farmers who only experienced two mechanisms, *network*

estimate is used as a reference for regulating farm-level nitrate leaching (https://www.overseer.org.nz/).

elaboration and *situated improvising,* did not change their learning logic, emphasising the importance of double loop learning and network reorientation in combination with these mechanisms. Our findings support those of Prager and Creaney (2017), Getz and Warner (2006) and Coutts et al. (2005), that without *network reorientation* change in practices does not move to changes in beliefs and values. Furthermore, participation in the NZ PEP exposed farmers to *double loop learning*, by jointly deciding which practices to implement, and reflecting on the opportunities and constraints of the practices a year later before deciding how to proceed. Indeed we observed evidence of *double loop learning* similar to that from I. Brown et al. (2016) through *network elaboration* as farmers innovated with new actors, such as researchers. This appears to be associated with a new learning logic and a reframing of environmental practices as needed for compliance to ensure business profitability. The latter was also observed as an outcome of *double loop learning* by I. Brown et al. (2016).

However, *double loop learning* did not change values underlying the *business* logic, though Inman et al. (2018) suggest that *double loop learning* might have potential to move farmers away from productivist values. While *double loop learning* changes underlying beliefs, triple loop learning is required to change values (Argyris and Schon, 1996; I. Brown et al., 2016). To achieve triple loop learning Preston and Stafford-Smith (2009) and I. Brown et al. (2016) identify the need to: i) reform networks, which we observed via *network elaboration* and *reorientation*; ii) supportive institutional arrangements, known *enabling dynamics*, but which were not always present in the PEPs; and iii) external (social) pressures for change, known as *external feedback loops*, but again not always present in the studied PEPs. This finding emphasises the importance of multiple mechanisms if wanting to move beyond practice change, by also establishing change in beliefs and values.

We did not observe changes in institutional logics on a field-level, likely due to the incomplete presence of a combination of macro-mechanisms. Firstly, *unobtrusive embedding* was not observed. The PEP monitor farms adopted and demonstrated environmental practices, which according to Pannell et al. (2006) would make adoption more likely to occur in their networks. A possible explanation for the lack of *unobtrusive embedding* is that it builds on *emotional intensification*. The absence of an emotional connection among farmers and research focusing on reducing nitrate leaching may have demotivated actors from actively participating in the practice, which is the key to successful *unobtrusive embedding* via the bottom-up approach of PEPs (Smets et al., 2012). Secondly, in both Scotland and NZ only one

sub-mechanism of *amplification* was observed, while for successful *amplification, scope expansion, increased frequency and regularity,* and *emotional intensification* are required together (Gray et al., 2015). *Emotional intensification* was lacking in both the Scotland and NZ PEP. We identified two reasons for this: i) most practices were framed as providing an economic win, which did not create emotional intensification around new beliefs and values, but instead connected with the existing business logic beliefs and values; and ii) *emotional intensification* arose due to sustained interactions, which was observed among monitor farmers, experts and researchers, but not with the network or discussion group farmers. The three sub-mechanisms strengthen each other, e.g. *emotional intensification* can create a connection to the new practice (and associated beliefs and values), which then makes it more interesting to discuss with others, leading to adoption of the new practices by other groups of farmers who in turn are connected to other groups (*scope expansion*). Due to an increased scope, there is an increase in *frequency and regularity* as more people are aware of the practices (Gray et al., 2015). However, if *emotional intensification* is not present, actors may not be interested in frequently sharing this knowledge in their networks, and therefore *amplification* did not occur.

In addition to micro- and macro-mechanisms, external feedback loops can function as an extra driver for change (McGuire et al., 2013). The changes proposed are ideally aligned with and encouraged by positive feedback loops, such as aligned policy and advice (Beers et al., 2014; Prager et al., 2016). For example, in NZ farmers were facing regulation to reduce nitrate leaching, which functioned as a positive feedback loop to start *situated improvising* and *network elaboration;* both mechanisms that occurred outside the influence of the PEP. However, the new practices were not yet included in the nutrient management tool Overseer used by Regional Councils to estimate on-farm nitrate leaching from farm practices. This created a negative, rather than a positive, feedback loop by not recognising the improved environmental outcomes from the new practices. A positive external feedback loop can also come from observed changes in environmental conditions (e.g. Van Herzele et al., 2013). However, effects caused by diffuse pollution, such as emissions of GHGs and nitrate leaching, are not readily observable by farmers, or attributable to individual farms and farming activity (Macgregor and Warren, 2006). This contributes to a disconnect between farmers' practices today and their distant and diffuse impacts on climate change or nitrate leaching (Geoghegan and Leyson, 2012). Therefore, micro-mechanisms, such as *network elaboration* and *reorientation,* are required to provide farmers with new insights, for example regarding the

effects of on-farm activities on diffuse pollution, along with other external feedback loops (e.g. recognition of farmers' environmental practices in industry awards). Some farmers in NZ, of which the farm was neighbouring a stream or river, mentioned the water quality in this stream as a feedback loop for change. However, most farmers did not observe any changes in environmental outcomes.

In addition to macro-mechanisms, enabling dynamics are required for a change in farming culture on an individual- and field-level. In the NZ PEP enabling dynamics were present, however, due to the incomplete presence of macro-mechanisms radiation to a field-level did not occur. This leads us to conclude that for practice-level change to diffuse to field-level aligning and combining micro-mechanisms, macro-mechanisms, and enabling dynamics are required.

5.7.2 Theoretical implications

The farmers who participated in this research were observed to retain values underlying the *business* logic by incorporating environmental compliance within this logic to maintain 'a profitable business'. Previous research shows that seeing environmental compliance as a factor to maintain a profitable business might stimulate farmers' extrinsic motivation (e.g. adopting environmental practices because of financial reasons), but decreases their intrinsic motivation (wanting to do the 'right thing') (Lokhorst et al., 2011; Van Herzele et al., 2013). This is problematic, because it suggests that there could be a lack of farmer buy-in to comply with environmental regulations, and not stimulate farmers to create more systemic change to achieve environmental outcomes (Burton and Paragahawewa, 2011; McGuire et al., 2013; Pretty, 2003).

Burton and Paragahewewa (2011) suggest that good farmer practices, beliefs and values are determined by the combination of economic (a profitable farm), social (how a farmer is seen by peers) and cultural (knowledge and skills) values. We hypothesise that the PEPs placed less emphasis on changing social and cultural beliefs and values by focusing on motivating farmers to take up 'win-win practices'. However, focusing on only the economic value is likely to be insufficient to establish change. Implementing a new practice, such as a change in crop management, makes the farm look different through, for example, less 'tidy' fields. From a social and cultural perspective, untidy fields might lead peers to place the farmer outside the 'good farming' category. This is problematic, because our findings suggest continuous

positive feedback from peers and experts is important for scope expansion. Kuhfuss et al. (2016), for example, emphasise the importance of peer influence on the adoption of new practices.

A way to address the decrease in social and cultural values is by environmental policies putting more emphasis on creating cultural and social values and thereby reshaping the identity of the 'good farmer'. This is possible via, for example, rewarding environmentally sustainable farmers for being 'good' farmers by providing certified qualifications through an organisation with high credibility in the field (Burton and Paragahawewa, 2011). Thirdly, this highlights the importance of providing *enabling dynamics* such as *institutional distancing* (Smets et al., 2012). By creating a new network of peers, farmers might be able to move away from the existing logics and feel more comfortable implementing practices adhering to new beliefs and values.

Lastly, in line with previous studies we find that there is a need to rethink PEPs by moving away from PEPs for creating practice change to PEPs for stimulating changes in beliefs and values that underpin more enduring practice change (Burton and Paragahawewa, 2011; Inman et al., 2018; Lokhorst et al., 2011; McGuire et al., 2013; Van Herzele et al., 2013). To be able to stimulate a change in farming culture, PEPs need to be framed as operating within a dynamic institutional and organisational environment that they can leverage by: recognising and drawing on positive external feedback loops and institutional clashes to enhance motivation for change (Beers et al., 2014; Klerkx et al., 2010); working on *emotional intensification* and *institutional distancing* to recognise and encourage changes in beliefs and values; and *network reorientation* and *elaboration* to stimulate connections with actors holding beliefs and values that support the practice (Coutts, 2005; Vereijssen et al., 2017). Hence, instead of conceptualising PEPs as operating from farmers out to others (Wood et al., 2014), we highlight the importance of conceptualising PEPs as being situated within a social network of actors and institutional environment with aligned and competing institutional logics that are simultaneously supporting and hindering cultural change. PEPS need to then draw on multiple mechanisms to align with actors with shared logics.

5.7.3 Practical implications

A complete change in values, beliefs and practices underlying farming culture studied in this paper was not achieved, due to the incomplete presence of micro-mechanisms, macro-

mechanisms, enabling dynamics and external feedback loops. A PEP cannot influence the presence of external feedback loops, but its timing can be aligned with, for example, new regulation regarding nitrate leaching or the emission of GHGs. This requires industries to work closely with governments to coordinate action (McGuire et al., 2013; Turner et al., 2017).

A PEP can support change by ensuring the presence of enabling dynamics, micro- and macro-mechanisms. Although both the NZ PEP and Scottish PEP have a deliberation and discussion process to determine which practices farmers will implement, we suggest a formal management board for each farm, consisting of monitor farmers, experts, and researchers, might be beneficial (Campbell et al., 2006). Such a management board can identify per farm which mechanisms and dynamics are required for that farm specifically and base their tasks on that. For example, by selecting and inviting experts and researchers to meetings, they can monitor the presence of the micro-mechanisms of *network elaboration* and *reorientation*.

Our study has shown that farmers are independently capable of network elaboration, however, to stimulate farmers to become knowledge creators instead of just consumers, PEPs have the ability, via *network reorientation*, to place the 'right' actors together to stimulate farmers to actively become co-creators of knowledge (Prager and Creaney, 2017). Furthermore, the board can influence the presence of enabling dynamics: by collecting the outcomes of the *situated learning process* to provide *organisational coordination*; by providing *continuous positive feedback* via examples of other successful PEPs and multi-actor collaborations; and by enhancing *cosmopolitanism* by introducing actors who have different logics than the farmers in the project.

A more difficult to achieve enabling dynamic is *structural assurance*. To allow the development of new values, farmers need to have a 'safe' environment in which they can develop these, without feeling pressure from their peers to conform to the existing dominant logics. One way PEPs can create a safe environment is by establishing a new peer group, consisting of actors interested in developing new practices (Burton and Paragahawewa, 2011). Again, the organisation behind a PEP can bring these farmers together.

Lastly, by framing PEPs as initiatives for stimulating changes in beliefs and values that underpin more enduring practice change, a PEP can support macro-mechanisms to ensure radiation on a field-level. *Scope expansion* can be achieved if all actors in a PEP share the

findings within their networks, which consequently leads to *increased frequency and regularity* of the new practices and associated values and beliefs. *Emotional intensification* is more difficult. Gray et al. (2015) show that emotions enhance when people feel part of a collective, e.g. guilt due to the negative effects of on-farm activities on public goods, such as deteriorating water quality. However, we think that *emotional intensification* should have a positive association, for example PEPs can enhance *emotional intensification* by farm visits during which a farmer can share their story of change and thereby inspire other farmers.

Besides implementing design aspects, knowing which micro- and macro-mechanisms should be present for successful change can contribute to the design of an evaluation framework for policies. When designing a policy, it might be useful to identify which mechanisms are already present amongst farmers as part of an '*ex-ante*' evaluation. During the PEP, a regular reflection on which mechanisms of change are absent, whether these are required for change, and how PEPs might contribute missing mechanisms, can be conducted to assure optimal PEP (re)design.

5.7.4 Limitations and future research

This research has created insight into change within a culture of farming from a farmer perspective. Although we have taken a holistic approach by collecting the overall values, beliefs and practices of a subset of farmers in Scotland and NZ, we need to acknowledge that the farming population is heterogeneous. Previous research has shown that farmers differ in their decision-making processes (e.g. Barnes et al., 2011; Barnes and Toma, 2012; Bewsell et al., 2007; Inman et al., 2018) and it is thus important to take this heterogeneity into account when approaching farmers for PEP participation.

As mentioned in the section 'practical implications', to enhance *cosmopolitanism* new actors with different logics should be introduced to the PEP. However, research has shown that experts or researchers lose credibility when they do not understand the farm (Ingram, 2008). Further research should focus on the tension between experts understanding the farm, situated within their own conceptualisation of farming culture, and being able to bring in new logics. This can be done by for example studying the negotiation process among different actors and how these lead to change (Osei-Amponsah et al., 2018).

5.8 Conclusion

This paper studied how Scottish and New Zealand farmers who, facing an institutional clash, changed practices, beliefs and values that constitute their farming culture and how an agri-environmental PEP contributed toward these changes. The findings show that only monitor farmers who are part of a PEP changed some of their beliefs and values, and that the combination of the micro-mechanisms of *situated improvising, network elaboration, double loop learning* and *network reorientation* are required for this change. The study did not observe changes on a field-level, due to a lack of complementary micro- and macro mechanisms and external feedback loops. The study furthermore shows that PEPs can be useful as an incremental or supportive tool by providing missing enabling dynamics, and micro- and macro mechanisms needed to achieve change. However, PEPs need to be supported by external feedback loops, such as regulation and observable changing environmental conditions on-farm. Therefore, timing of these initiatives is crucial for success. Lastly, this study highlights that to achieve environmentally sustainable farming, policies should address the cultural embeddedness of current farm practices.

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6. Conclusion

This concluding chapter first summarises the findings of this research and places these in relation to PEP evaluation, evaluation in general and behavioural change. Then it discusses the limitations and learnings from each of the papers, providing suggestions for further research before drawing conclusions.

6.1 Summary of the findings

The thesis develops and applies methods for agri-environmental PEP evaluation by answering four questions. The question 'What is the current state of practice regarding the evaluation of PEPs?' was answered in Paper 1 by conducting a systematic literature review. The main gaps in the literature of *ex-post* PEP evaluation were: 1) there is a lack of qualitative evaluations of PEPs; 2) often the accounting for endogeneity and selection bias is incorrect; 3) evaluation planning is often lacking before PEP initiation; 4) the majority of the evaluations do not include environmental impact outcomes; 5) very few evaluations have been conducted in developed countries.

Paper 2 addressed the question: 'How can both environmental and human-social factors be evaluated for an agri-environmental PEP?'. This question was answered by developing and applying a framework for measuring environmental factors, such as the adoption of renewable energy and soil management practices, and human-social factors by measuring indicators for social learning and increased skills and resilience. To address gaps 1, 2, 4 and 5 identified in the literature review, mixed methods were used for evaluation, including a quasi-experimental method to account for selection bias; environmental impact outcomes, such as renewable energy production and soil management practices, were measured; and a case study in Scotland, a developed country, was selected. The findings show that PEP farmers had a higher level of practice adoption than non-PEP farmers. However, the findings for the human-social indicators were mixed. Furthermore, there was a difference observed in practice adoption between farmers having participated in the PEP earlier, between 2010-2013, compared to farmers having participated in the PEP recently, between 2014-2017. These last two findings raised the question of whether the PEP had been able to induce

sustained change by not only changing farmer practices, but also underlying values and beliefs. This was identified as a sixth gap in literature.

Paper 3 addressed the following question: 'Which factors influence farmer decision-making related to diffuse water pollution reduction practices?'. The paper addressed gaps 3 and 5 by conducting an explanatory study into the factors that influence farmer decision-making around the uptake of nitrate leaching measures in New Zealand. The paper analysed semi-structured interviews by using a grounded theory approach to identify these factors, and developed a typology of farmers, based on the factors that influence their decision-making. The study suggests that PEP design can be improved by identifying typologies of farmers included in a programme, in order to tailor programme design and approaches.

Paper 4 addressed the question: 'Does participation in a PEP induce a change in institutional logics?' The paper addressed gap 6, identified in Paper 2, by looking at the sustained cultural change induced by PEPs. The paper applied the institutional logics perspective, in which the dominant New Zealand and Scottish farming culture was studied by looking at a change in practices, beliefs and values. New Zealand and Scottish PEP farmers were compared to non-PEP farmers to identify change and the mechanisms that contributed to change. Only slight changes in practices, beliefs and values were observed. It is concluded that PEPs can be useful as an incremental or supportive policy tool, but for optimal change enabling dynamics, micro- and macro mechanisms are required. Furthermore, PEPs need to be supported by external feedback loops, such as regulation and observable changing environmental conditions on-farm. Therefore, timing of these initiatives is crucial for success.

6.2 Broader implications of the research

6.2.1 A framework for evaluation of agri-environmental PEPs

This thesis aimed to identify and conduct a holistic evaluation of agri-environmental PEPs. However, a holistic evaluation proved challenging, because: i) no baseline or mid-term data was available for the case studies; ii) no participatory evaluation approach was set up; and iii) only farmers were included in the evaluation. Limitations i and ii were caused by both the Scotland and New Zealand PEP being in their final stage at the start of the PhD, making it impossible to collect baseline or mid-term data for longitudinal evaluation and a participatory evaluation set-up. Limitation iii was caused by time restrictions; a multi-actor evaluation required another set of at least 10 interviews, for which I did not have time. Although it was

not possible to conduct a more comprehensive evaluation in this thesis due to data and time restrictions, the identified shortcomings lead to suggestions for a comprehensive framework for evaluation. The framework provides insight into the different aspects (inclusion of evaluation from the design phase of the PEP, reflection on the participatory aspect of the PEPs, reflection on the needs and requirements of participants, and inclusion of a measurement of sustained change), and into how the research undertaken in this thesis relates to this framework (Fig. 12).

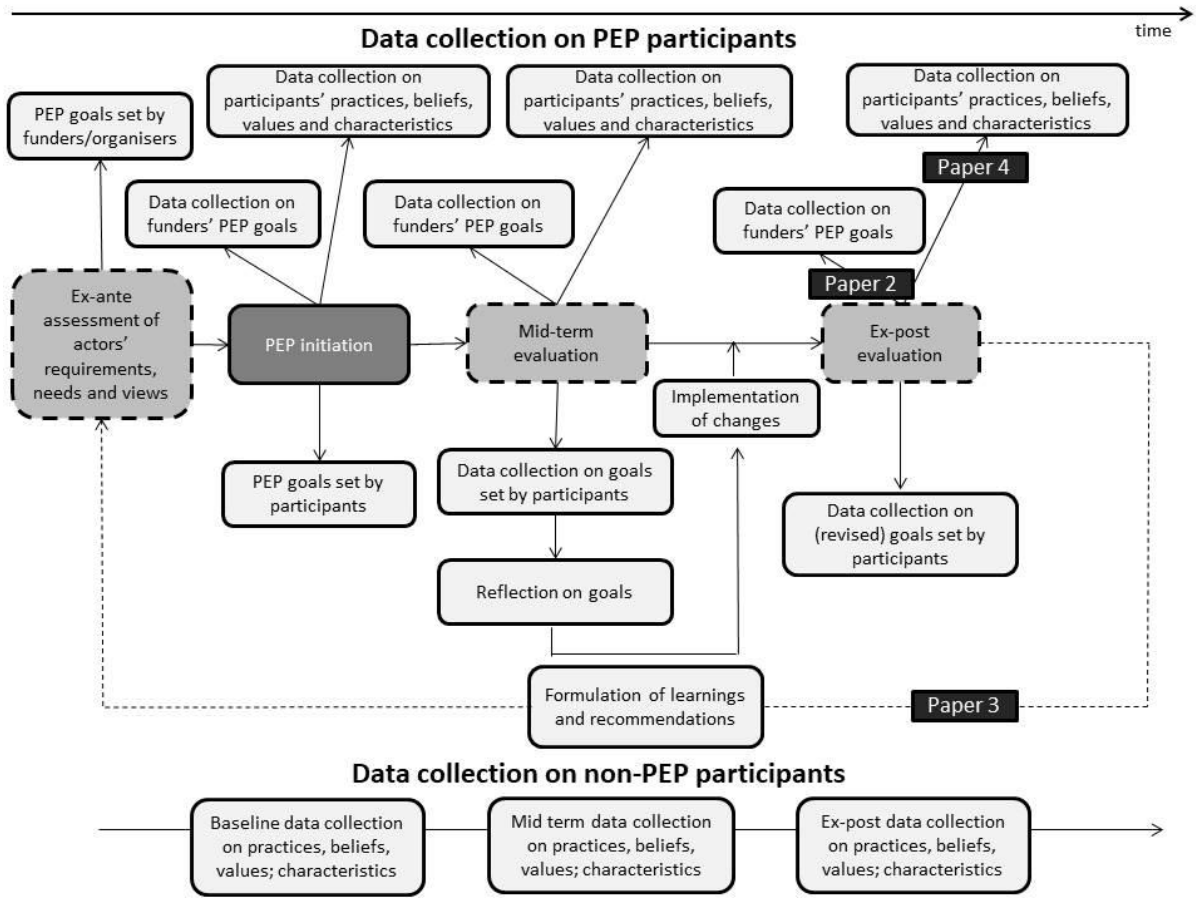

Figure 12. A framework for PEP evaluation. The framework includes the points of data collection and the aspects of evaluation each paper in this thesis has focused on.

6.2.1.1 Description of the framework

The first step of the framework consists of an evaluation before programme initiation, in which an overview is made of the needs, requirements and views of involved actors by the funders and/or programme designers. This is required to design optimal support on learning of complex agricultural ideas and practice-based innovation (Sewell et al., 2017). At initiation of the PEP, data can be collected on the goals formulated by the funders and/or programme

designers. Furthermore, baseline data should be collected on participants to allow a measurement of change in practices. This should consist of data on the characteristics of farmer participants, such as farm size, practices on farm, beliefs about running the farm, as well as data based on the goals set by the participants, to account for the participatory process in which the participant goals cannot be rigidly defined at the start of the PEP (Dart, 2000). Following the baseline data collection, a *mid-term* evaluation should be conducted. The aim of a *mid-term* evaluation is to reflect and analyse whether the PEP is achieving its objectives, both from a funder and participant perspective. This requires a reflexive perspective on evaluation (van Mierlo et al., 2010): 'a critical scrutiny of things that are usually taken for granted, in such a way that their historically grown self-evidence is challenged' (Loeber et al., 2007: 84). This allows established practices (institutions) to be challenged by (participatory) inquiry and dialogue (Arkesteijn et al., 2015), which in turn can lead to reformulation of the objectives and methods to optimise PEP design. At the end of the PEP an *ex-post* evaluation should be conducted to gain insight in the goals set out by funders, organisers, and participants at programme initiation (Faure et al., 2012). Data on the funder and (potentially reformulated) participant goals are collected for this purpose. To look beyond practice adoption, the start data on practices, beliefs, and values of participants can be compared to the same data collected at the end of the programme. If change has occurred it should be possible to identify whether the mechanisms leading to this change were part of the PEP. Based on the evaluation learnings, the design of future programmes can be optimised. Ideally, this leads to funder goals that are increasingly aligned with those of the participants.

In addition to monitoring PEP participants, it is also necessary to monitor a group of non-participant farmers, to assure changes in practices, beliefs and values can be attributed to the PEP (Vereijssen et al., 2017). This requires *baseline*, *mid-term*, and *ex-post* data collection on a group of non-PEP participants. Furthermore, it is important to note that change in farming culture is not possible unless institutional surroundings, including different actors, are changing too (Vereijssen et al., 2017). A suggestion for further research on this topic is included in the 'additional research' section of this chapter.

6.2.1.2 Evaluation in practice

As previously stated, due to the public investment in PEPs, the increasing requirement for accountability by policy-makers and funding bodies, and the uncertainty around the (potential) contribution to environmental targets, PEPs need to be reliably evaluated (Faure et al., 2012; Klerkx et al., 2016). Although this research highlights that good evaluation practice does not need to require a large time investment, the feasibility of collecting *baseline*, *mid-term* and *ex-post* data on participant characteristics and programme goals can be questioned.

This suggests that agents in charge of evaluation need to make a decision on which aspects of evaluation to focus on. This decision might be made based on which evaluation method provides the clearest learning to make the design of future programmes more efficient and cost-effective. When the focus of PEPs is to contribute to the improvement of non-market goods, such as clean air and water, the benefits of a decision might be difficult to quantify (Moran et al., 2007). Valuation methods, such as the travel cost method, in which the travel costs of an individual is used to calculate the value of a site (Ward and Beal, 2000), or benefit transfer, in which the data from a travel cost method in a particular site is used to estimate the value of a different site (Loomis, 1992), can be used to help estimate the best economic return of a policy decision (Allen and Loomis, 2008). However, decision-making on which evaluation approach is most valuable does not only depend on being able to quantify non-market goods, but also on quantifying wider behavioural change, such as change in beliefs and values. Further research can explore how to quantify the contribution to non-market goods, as well as quantify the value of the change in participant beliefs and values, to make a decision on which evaluation is most suitable for a certain PEP.

Although there are guidelines for evaluation (e.g. HM Treasury, 2011, 2003), evaluation does not seem to be a standard aspect of PEP design. For example in the case studies of Paper 2, 3, and 4, no evaluation plan was set up until the evaluation part of this PhD was developed. Informal discussions with programme designers and funders have led me to identify the following causes for the lack of evaluation. Firstly, project applicants and designers are usually not evaluators. The lack of evaluation skills and background in this topic complicates a good evaluation set-up. Secondly, evaluation is costly and if a programme exceeds budgets, evaluation is often the first aspect facing budget cuts. Thirdly, evaluation plans are often not a requirement for funding applications. These three points suggest that although guidelines

on evaluation are available, the limited requirement for evaluation by the funder (often the government) and the lack of evaluation training is presenting a barrier to evaluation. Hence, if evaluation is to become a standardised aspect of PEP design, funders have to require the need for evaluation, provide training for programme designers, and acknowledge the need for evaluation in the budget allocation.

6.2.2 The role of mixed methods and the purpose of evaluation

PEP evaluation has so far mainly been conducted for the purpose of collecting evidence for accountability, in order to for example obtain additional funding and programme continuation (Faure et al., 2012; Klerkx et al., 2016). The need for scientific evidence is supported by the Evidence Based Policy perspective, which leads most evaluations to be conducted by applying (quasi-) experimental research designs (Munro, 2014). A few studies were found criticising this perspective, for example because it limits the questions studied, by failing to take the context of the programmes into account (Montuschi, 2014; Munro, 2014). The thesis has highlighted the shortcomings of only using quasi-experimental design for evaluation by showing that it does not reflect the complete purpose of the PEP, such as to enhance social learning and management skills. This thesis has contributed to bridging the gap between quantitative and qualitative evaluation methods, by emphasising the added-value of using mixed methods. Furthermore, research in the thesis focused on short-term, as well as long-term expected changes due to PEP participation. This research has introduced a new way of evaluating change due to PEP participation, by using an institutional logics lens, which not only looks at practice adoption, but also how this aligns with farmer' beliefs and values. Supported by the innovation systems approach (e.g. Klerkx et al., 2012), the thesis shows that the direct physical environment, as well as the institutional environment requires change for farmers to change to a more environmentally friendly farming system.

6.2.3 Behavioural change

The thesis has provided insight into behavioural change regarding diffuse pollution mitigation. Paper 4 shows that management change around diffuse pollution requires more than voluntary enhancement to establish change, which is partly caused by the seemingly distant temporal and spatial effects of diffuse pollution activities (Geoghegan and Leyson, 2012). This suggests that for real behavioural change around complex issues such as climate change and water pollution, multiple policy approaches are required in addition to PEPs, such

as regulation and market-based instruments. Furthermore, the farmer typology described in Paper 3, highlights the need to communicate with different farmer groups in different ways to understand their response or lack thereof to certain policy instruments. This supports the need for different instruments for the most effective solution and aligns with the call for multiple policy approaches.

6.2.4 The challenges around interdisciplinary research

This thesis has used an interdisciplinary approach towards evaluation of PEPs, by using an econometric method for evaluation, theory from organisational studies to provide a framework for measuring sustained change, and qualitative methods to study the topic of social learning. However, the application of methods and theories from a range of disciplines has proved challenging in terms of finding outlets for publication of my work. For example, Paper 2 was initially submitted to the *Journal of Agricultural Economics*. By submitting the paper to this journal, I wanted to introduce the importance of mixed methods evaluations to provide insight into PEP functioning beyond practice adoption. However, the reviewers suggested that the paper required an elaboration on the quantitative methods and results, and minimisation of the qualitative aspects of the paper, to make it publishable in an agricultural economics journal. This example shows the difficulty of proposing interdisciplinary approaches to a more mainstream economics audience, as well as how the institutionalisation of certain forms of evaluation practices, in this case the (quasi-) experimental approach, is reinforced by the publication process in agricultural economics journals.

6.3 Limitations and learnings from the research

6.3.1 Limitations and learnings from Paper 1

The focus of the literature review was on *ex-post* evaluations, because the case studies selected for the PhD study were in the last phase of the programme, thus only allowing an *ex-post* evaluation. However, to place 'evaluation' in a wider perspective, the initial literature review would have benefitted from including *ex-ante* and *mid-term* evaluations. Furthermore, an overview of the evaluations conducted in grey literature could have helped to identify the gaps at a practice level and provide more specific recommendations for evaluators.

6.3.2 Limitations and learnings from Paper 2

The evaluation conducted in Paper 2 consisted of a quasi-experimental evaluation to test practice adoption amongst PEP participants, followed by semi-structured interviews to gain insight into social learning and increased management skills due to PEP participation. Although semi-structured interviews offered some insight into the views of participants, a truly participatory evaluation design, in which participants were asked to formulate their programme aims before programme initiation, was lacking. Including such an evaluation is important because predetermined measures and outcomes may not be compatible with the programme aims of participants (Lees, 1990; Webber and Ison, 1995). In the future set-up of longitudinal evaluation, it is important to evaluate the aims of the funder, as well as the participants' aims.

A second limitation of the study was the lack of good indicators available to identify the GHG emission reduction due to programme participation. This limitation was partly derived from the impossibility of collecting longitudinal data, which made monitoring GHG emission reduction over time particularly complex. Furthermore, the farmers who participated in the phone survey did not know the interviewers personally, which made it less likely that they were willing to share a lot of detailed data about their farms. Lastly, the farmers were not asked to prepare for the phone interviews, and therefore it was necessary to work with data they were likely to have to hand. These last limitations can be addressed by conducting data collection at multiple points in time (as indicated in Fig. 12), and indicating the points of data collection beforehand, so farmers are able to prepare the data required for evaluation.

6.3.3 Limitations and learnings from Paper 3

The data for Paper 3 was collected via qualitative interviews and meeting observations. Both the theory and methods applied in this paper were new to me, which created a learning process during the PhD. Initially, I aimed to minimise the researchers' preconceptions and assure the finding of interest was grounded in data (Glaser and Strauss, 1967). Therefore, I did not conduct an extensive literature review until after completing the data collection. However, this complicated the timely identification of interesting and new findings, as well as placing the findings within the context of the current literature (e.g. Dunne, 2011; Thornberg, 2012). To address this issue, I explored the principles of abductive reasoning in Paper 4, which allows the researcher to move back and forth between the data and literature

to formulate the best possible explanations (Bryant, 2009; Thornberg, 2012). Although the data for Paper 4 was already collected during field work for Paper 2 and 3, the approach allowed a multi-step method towards data analysis (Thornberg and Dunne, 2019). An *initial literature review* was conducted before the start of data analysis to identify the gap in literature. Consequently, an *ongoing literature review* was conducted during the analysis, leading to initial hypotheses to explain the findings. Lastly, a *final literature review* was conducted at the end of the analysis, in which the theory was formulated and the findings were related, compared and contrasted with the findings of previous studies. In future work, I will apply this multi-step method during data collection as well, to assure the timely identification of interesting and new findings and to be able to place these in relation to current literature.

6.3.4 Limitations and learnings from Paper 4

A limitation to Paper 4 was the extent to which a comparison could be made between Scotland and New Zealand. Case studies in both countries were selected to conduct a comparative study on policy approaches and extension in contexts with more or less regulation. However, the Scotland PEP was based on the farming systems research design (Darnhofer et al., 2012b), whereas the New Zealand PEP was based on the co-innovation approach (Klerkx et al., 2012). Due to these differences in PEP design, it was difficult to identify the influence of the institutional context of Scotland versus New Zealand. This is a lesson for planning future studies, because comparative studies on policy approaches and extension in contexts with more or less regulation could be highly valuable for countries facing changes in agricultural policy, including for post-Brexit policy in the UK.

A further limitation in Paper 4 was the use of the oral history interviewing method, in which participants were asked to describe their experiences over the years by providing examples (Bryman, 2012). Unfortunately, participants could not always correctly remember when changes were made and hence, the quality of the findings could have been improved if interviews at the start of the programme had been conducted as well. Again, this underlines the importance of collecting baseline data for optimal evaluation results.

6.4 Further research

The data collected for this thesis has been used for a number of additional research outputs (which are not included in the thesis itself), and these are outlined below. Also outlined are a number of other areas for further research.

6.4.1 Spatial evaluation

Paper 1 highlighted that PEP evaluations do not always correctly account for endogeneity issues, which arise from incorrectly accounting for non-random selection of participants in PEPs (Knook et al., 2018). Often when only cross-sectional data are available for *ex-post* evaluation, matching methods based on observable characteristics are applied (e.g. Cavatassi et al., 2011; Läpple and Hennessy, 2015). McKenzie et al. (2010) state that although methods such as propensity score matching (PSM) provide a more accurate estimation of what would have happened in the absence of a programme, than if no method is applied for selection bias, matching based on observable characteristics can still lead to an estimation bias of up to 20%. In order to make that bias as small as possible, it is important to optimise the quality of the observable characteristics included in matching. One of the currently ignored factors in PSM are the processes which lead to inference of spatial dependence between farmers, which may occur via: i) other farmers located in close proximity influencing PEP participation; and ii) other farmers sitting in the PEP meetings influencing the choices of practice adoption. Studies have modelled the spatial effects using exogenous variables to compare the intended outcomes between trained and neighbouring farmers (Feder et al., 2004b; Jørs et al., 2016), but have been neglecting or inappropriately modelling the spatial dependence between farmers, which in turn may lead to an inaccurate evaluation of PEPs. Therefore, a fifth paper forthcoming from the thesis has included effects of spatial dependence by applying spatial propensity score matching (SPSM) to estimate the impact of participation in a PEP on the adoption of climate change mitigation practices. Data collected for Paper 2 and 4 was used for this paper. The results show that PEP participation facilitates the uptake of mitigation practices and that spatial dependence exists in farmers' decision-making, indicating the need for the inclusion of spatial factors. The contribution of this study is two-fold. Firstly, it includes a methodological advance by combining spatial econometric analysis with propensity score matching in evaluating practice change due to PEP participation. Secondly, it is one of the first evaluations of a climate change PEP. The inclusion of spatial effects in quantitative evaluations and evaluation of a climate change PEP will help decision-makers with how to

measure the possible contribution of PEPs towards achieving emission reduction targets in the agricultural sector.

The study described above has resulted in the following manuscript: *Spatial dependence in evaluating the outcomes of climate change extension programmes.* The paper was presented at the Annual Conference of the Australasian Agricultural and Resource Economics Society in Melbourne in February 2019 and will be submitted to the *Journal of Agricultural Economics* in January 2020. This paper has been co-authored by the candidate and Dr. Wei Yang.

6.4.2 Behavioural spillover effects

As identified in Paper 2, there is a lack of knowledge on the effects that stimulating low-cost mitigation practices has on farmers' attitudes and behaviours. Previous research has shown that stimulating the adoption of climate change mitigation practices at an individual level might negatively influence the support for national climate change policy (Hagmann et al., 2019; Weber, 1997; Werfel, 2017). This phenomenon has only been studied to a limited extent in the agricultural sector (Hansen et al., 2004; Weber, 1997) and especially the mechanisms leading to these behavioural spillover effects, i.e. the effects of an environmental action on a subsequent environmental action not targeted by the initial intervention, are unclear. Because PEPs stimulate the voluntary uptake of climate change mitigation practices, it might be possible that this also lowers the support for national policy on climate change. Therefore, a mixed methods approach consisting of a phone survey and semi-structured interviews with Scottish farmers (data collected for Paper 2), was conducted to identify spillover effects and the mechanisms responsible for these effects. The phone survey included a quantitative experiment including two groups of farmers: i) farmers who were participating in the PEP in Scotland; and ii) farmers not participating in any such programme. These two groups of farmers were asked to indicate their level of support for national climate policy by expressing their support for the introduction of a carbon tax. Additionally, respondents were asked questions which aimed to identify mechanisms underlying possible spillover effects, based on the framework of Truelove et al. (2014). After applying propensity score matching to account for differences between the PEP and non-PEP group, the results did not show any evidence of negative or positive spillover effects. The analysis of semi-structured interviews indicated this is partly due to the 'calculation-based'

decision-making mode farmers apply, which means farmers assess the uptake of a new practice on the cost-benefit ratio of the practice compared to other alternatives (Truelove et al., 2014). However, the analysis also showed that the question on national climate change policy (a carbon tax) received low support from all the farmers. Hence, the absence of a spillover effect can be due to the formulation of the national policy question.

The paper was presented at the 168th EAAE seminar in Behavioural Perspectives in Agricultural Economics and Management in February 2019: *Increasing understanding into the presence of behavioural spillover effects in the agricultural sector.* The findings led to the development of a new research proposal co-authored by the candidate, Dr. Zack Dorner, and Dr. Pike Stahlmann-Brown.

The majority of agri-environmental actions in New Zealand are based on the voluntary uptake by farmers, which sparked our interest into studying the effect of stimulating the uptake of individual environmental actions on the support for national climate change policy. A somewhat overlooked group in studying the effect of stimulating the uptake of voluntary agri-environmental practices on subsequent actions, are lifestyle farms. In New Zealand these farms only cover approximately 6 percent of agricultural land, but due to the large number of lifestyle farms (approximately 140.000 in 2014) (New Zealand Government, 2018), the farmers represent approximately 10 percent of the New Zealand electoral population (Stats NZ, 2019). Therefore, their vote might have a significant effect on national environmental policy support. To successfully include lifestyle farmers in future environmental policy it is important to better understand how this group might approach environmental action. As part of the Survey for Rural Decision Makers 2019, a national survey conducted every two years in New Zealand, yielding about 3000-5000 respondents (Landcare Research, 2019), a test for negative spillover (also referred to as 'crowding out') effects was conducted. In the experimental set-up fifty percent of the respondents received information on an environmental action: the importance of individual action to save energy and reduce waste. All respondents were then asked to express their support for an environmental action at a national level, either: i) a climate change mitigation action that would affect all users of petrol and diesel; or ii) a biodiversity conservation measure requiring pest control on private properties. A difference-in-differences approach was used to test whether any observed crowding out was the same between different types of environmental goods. Mechanisms responsible for the potential crowding out effects were tested by asking about the decision

mode of the farmers, based on the framework of Truelove et al. (2014). The initial analysis (based on approximately 50% of the responses) showed that the environmental nudge reduced support for environmental action at a national level by 5%. There was no difference observed in crowding out between the two different types of environmental goods. The decision-mode questions showed that a strong emphasis on financial calculation of green technology led to a small crowding in effect from the environmental nudge.

Findings from this study have been presented at the Annual Conference of the New Zealand Agricultural and Resource Economics Society in August 2019: *Does individual action crowd out support for national action on environmental issues amongst lifestyle farmers*. Currently, the final data set is being analysed and a paper is being written up for submission to *Environment and Behaviour*.

6.4.3 Legitimacy to farm

Paper 2 highlighted that there is limited knowledge on the sustained environmental change farmers make due to environmental policy and which mechanisms are responsible for this. In Paper 4 this gap is addressed by applying institutional theory to study change in the culture of farming due to PEP participation. This study shows a pressure that leads to change: calls from societal actors to adopt more environmentally friendly farming practices. This pressure influences farmers' social licence to operate: when the values of the business and its operational processes meet the expectations of local communities and other concerned stakeholders (Dare et al., 2014). This licence is strongly linked to the 'legitimacy' of farms (Deephouse et al., 2017): 'a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions' (Suchman, 1995: 574). Quotes from interviews in New Zealand show farmers aim to retain this legitimacy by, for example, planting trees near the road, so the public, who has a large influence on the social licence to operate, perceives the farm as more environmentally friendly. However, it is unclear which structural mechanisms farmers apply to gain legitimacy. I suggest that institutional theory can be used to increase understanding into the mechanisms farms use to maintain their social licence to operate. Research into this topic could introduce a new theoretical lens to increase understanding into environmental change in the profession of farming. From a practical perspective, the

study could provide advisors with more in-depth knowledge about the mechanisms farmers apply to maintain legitimacy and how PEPs can help in that.

6.4.4 A qualitative evaluation of the role of facilitators in agri-environmental participatory extension programmes

As emphasised earlier in the conclusion, evaluation practices should not only focus on farmers to understand what a successful PEP should look like, but also include the role of other actors, such as advisors and facilitators (Hauser et al., 2016). A study by Vrain and Levett (2016) has focused on what a successful advisor role entails in the uptake of mitigation practices and it is shown that the use of material mechanisms, such as grants and subsidies, are key to successful advise. However, it is not known what non-material mechanisms, such as communication tools, successful advisors and facilitators use, or how this changes due PEP participation. It would be interesting to conduct research into the mechanisms facilitators use to increase change in practices, beliefs, and values amongst farmers, as well as how these mechanisms have changed over the years. A similar approach to Paper 4 can be applied, in which facilitators are interviewed before, during and after PEP participation to identify their logics, how these evolve due to PEP participation, and which mechanisms they use.

6.5 Concluding remarks

This thesis has focused on the evaluation of agri-environmental participatory extension programmes. The research has shown that different theories and methods should be used for holistic PEP evaluation. Furthermore, data should be collected before, during and after the programme to be able to conduct *ex-ante*, *mid-term* and *ex-post* evaluations. Besides the development of a framework, the research in this thesis has shown that PEPs in themselves are not sufficient to achieve a change in farm management towards complex problems such as climate change or water quality. The complexity of these issues requires, in addition to a participatory approach to develop new strategies to communicate the complex and often-invisible consequences of farm management, regulation and market-based instruments to achieve change on an on-farm level.

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Appendixes

Appendix A. Supplementary material for Paper 1

Table 6. Overview of the evaluation studies included in the systematic review, categorised by the aspects studied.

Nr	Authors	Title	Journal	Location	Programme delivery	Methods	Outcome variables	Inclusion evaluation
1	Bekele et al. 2013	The impact of group based training approaches on crop yield, household income and adoption of pest management practices in the smallholder horticultural subsector of Kenya	Journal of Sustainable Development in Africa	Kenya	FFS and common interest groups (CIGs)	Quantitative evaluation: PSM	Yield; income; pest management	No
2	Benin et al. 2011	Returns to spending on agricultural extension: the case of the National Agricultural Advisory Services (NAADS) program of Uganda	Agricultural Economics	Uganda	Participatory advisory services (programme name: National Agricultural Advisory Services)	Quantitative evaluation: PSM & DiD	Income	No
3	Bentley et al. 2007	Comparing farmer field schools, community workshops, and radio: teaching Bolivean farmers	Journal of International Agricultural and Extension Education	Bolivia	FFS	Quantitative evaluation: NCIA	Knowledge acquisition; crop management; use of healthy seed; crop rotation and incorporation of manure;	Yes

		about Bacterial wilt of potato					knowledge diffusion	
4	Bhandari 2012	Integrated pest management farmer field school for sustainable agriculture	International Journal of Agricultural Science, Research and Technology	Nepal	FFS	Quantitative evaluation: NCIA	Knowledge acquisition; knowledge diffusion	No
5	Bourne et al. 2017	A network perspective filling a gap in assessment of agricultural advisory system performance	Journal of Rural Studies	Rwanda, Kenya, Tanzania	Participatory advisory services	Quantitative evaluation: other	Information flow; capacity for collective action	No
6	Bruges & Smith 2007	Participatory approaches for sustainable agriculture: a contradiction in terms?	Agriculture and Human Values	New Zealand	Participatory farmer research groups	Qualitative evaluation	Potential and constraints of participatory approaches	No
7	Bunyatta et al. 2006	Farmer Field School Effectiveness for Soil and Crop Management Technologies in Kenya	Journal of International Agricultural and Extension Education	Kenya	FFS	Quantitative evaluation: NCIA	knowledge acquisition; knowledge diffusion	No
8	Cavatassi et al. 2011	How do agricultural programmes alter crop production?	Journal of Agricultural Economics	Ecuador	FFS	Quantitative evaluation: PSM	Production technology changes; yield	No
9	David & Asamoah 2011	The impact of farmer field schools on human and social	The Journal of Agricultural Education	Ghana	FFS	Quantitative evaluation: NCIA	knowledge acquisition; experimental skills;	No

		capital. A case study from Ghana	and Extension				social capital	
10	Davis et al. 2012	Impact of farmer field school on agricultural productivity and poverty in east africa	World Development	Kenya, Tanzania, Uganda	FFS	Quantitative evaluation: PSM and DiD	Productivity; income	Partly: Baseline survey conducted, but incomplete. Hence, recall data are used
11	Dinpanah et al. 2010	Analysis of effect of farmer field school approach on adoption of biological control on rice producer' characteristics in Iran	American-Eurasian Journal of Agricultural and Environmental Science	Iran	FFS	Quantitative evaluation: NCIA	Knowledge acquisition	No
12	Dolly 2009	An assessment of the implementation and outcomes of recent farmer field schools to improve vegetable production in Trinidad and Trabago	Journal of International Agricultural and Extension Education	Trinidad & Tabago	FFS	Quantitative evaluation: NCIA	Relevance and response to local concerns; knowledge acquisition; knowledge diffusion; local institutionalisation and organisational development; impact on relationships; FFS integration into existing programmes	No
13	Duveskog et al. 2011	Farmer field schools in rural Kenya: a transformative learning experience	Journal of Development Studies	Kenya	FFS	Qualitative evaluation	Impact of programme on farmers' daily lives, social learning	No

14	Erbaugh et al. 2001	Evaluating farmers' knowledge and awareness of integrated pest management (IPM): assessment of the IPM collaborative research support project in Uganda	Journal of International Agricultural and Extension Education	Uganda	FFS	Quantitative evaluation: NCIA	Knowledge acquisition	No
15	Erbaugh et al. 2010	Assessing the impact of farmer field school participation on IPM adoption in Uganda	Journal for International Agricultural and Extension Education	Uganda	FFS	Quantitative evaluation: NCIA	Knowledge acquisition; pesticide use	No
16	Feder et al. 2004a	Sending farmers back to school: the impact of farmer field schools in Indonesia	Review of Agricultural Economics	Indonesia	FFS	Quantitative evaluation: DiD	Yield; pesticide use	Partly: Baseline survey conducted, but the final evaluation required additional questions
17	Feder et al. 2004b	The acquisition and diffusion of knowledge: the case of pest management training in farmer field schools, Indonesia	Journal of Agricultural Economics	Indonesia	FFS	Quantitative evaluation: DiD	Knowledge acquisition; knowledge diffusion	Yes
18	Godtland et al. 2004	The impact of farmer-field-schools on knowledge and productivit	Economic Development and Cultural Change	Peru	FFS	Quantitative evaluation: PSM	Productivity; knowledge acquisition	No

		y: a study of potato farmers in the Peruvian Andes						
19	Gockowski et al. 2010	An evaluation of farmer field school induced changes in Ghanaian cocoa production	Journal of International Agricultural and Extension Education	Ghana	FFS	Quantitative evaluation: NCIA	Production; pesticide use; crop management practice	No
20	Guo et al. 2015	Farmer field school and farmer knowledge acquisition in rice production : experimental evaluation in China	Agriculture, Ecosystems and Environment	China	FFS	Quantitative evaluation: RCT	knowledge acquisition	Yes
21	Hennessy & Heanue 2012	Quantifying the effect of discussion group membership on technology adoption and farm profit on dairy farms	The Journal of Agricultural Education and Extension	Ireland	Farmer discussion groups	Quantitative evaluation: NCIA	technology adoption; profit levels	No
22	Hill et al. 2017	Evaluation of knowledge transfer; conceptual and practical problems of impact assessment of farming connect in Wales	Journal of Rural Studies	United Kingdom	Farmer discussion groups (programme name: Farming Connect)	Quantitative evaluation: DiD	Income; turnover; farm sales; farm profits; farm labour	Yes
23	Istriningsih & Dewi 2015	Performance of soybean's farmer	Asian Journal of Agriculture and	Indonesia	FFS	Quantitative evaluati	Productivity	No

		field school-integrated crop management in central Java and West Nusa Tenggora provinces, Indonesia	Development			on: NCIA		
24	Jones et al. 2014	Assessing participatory processes and outcomes in agricultural research for development from participants' perspective	Journal of Rural Studies	Mali, Niger, Burkina Faso	Participatory training groups (programme name: Participatory Plant Breeding Project)	Qualitative evaluation	Strengthening of practical and strategic outputs to contribute to food security, social learning, empowering participants	No
25	Jors et al. 2014	Do Bolivian small holder farmers improve and retain knowledge to reduce occupational pesticide poisonings after training on integrated pest management?	Environmental Health	Bolivia	FFS	Quantitative evaluation: NCIA	knowledge acquisition; pesticide use	Yes
26	Jors et al. 2016	Impact of training Bolivian farmers on integrated pest management and diffusion of knowledge to neighboring farmers	Journal of Agromedicine	Bolivia	FFS	Quantitative evaluation: NCIA	Knowledge diffusion; pesticide use	Yes, but the control group was not included in the baseline study. This included only the FFS farmers and neighbou

								ring farmers.
27	Kadiyala et al. 2016	Adopting agriculture platforms for nutrition: A case study of a participatory, video-based agricultural extension platform in India	Plos One	India	Agricultural self-help discussion groups	Qualitative evaluation	Nutrition behaviour	No
28	Kangmennaang et al. 2017	Impact of a participatory agroecological development project on household wealth and food security in Malawi	Food Security	Malawi	Farmer to farmer extension (programme name: Farmer to Farmer Agroecology project)	Quantitative evaluation: PSM and DiD	Household income; food security	Yes
29	King et al. 2008	Does participatory action learning make a difference? Perspectives of effective learning tools and indicators from the conservation cropping group in North Queenslan d, Australia	The Journal of Agricultural Education and Extension	Australia	Participatory action learning	Qualitative evaluation	-	No
30	Kraaijvanger et al. 2016	Considering change: evaluating four years of participatory experimentation with farmers in Tigray	Agricultural Systems	Ethiopia	Farmer experimentation groups	Quantitative evaluation: NCIA; interviews and observations	Functional and human-social aspects	Yes

		(Ethiopia) highlighting both functional and human-social aspects						
31	Läpple et al. 2013	Quantifying the economic return to participatory extension programmes in Ireland: an Endogenous Switching regression analysis	Journal of Agricultural Economics	Ireland	Farmer discussion groups (programme name: Dairy Efficiency Programme)	Quantitative evaluation: ESM	gross margins	No
32	Läpple & Hennessy 2015	Assessing the impact of financial incentives in extension programmes: evidence from Ireland	Journal of Agricultural Economics	Ireland	Farmer discussion groups (programme name: Dairy Efficiency Programme)	Quantitative evaluation: PSM	Yield; gross margins	No
33	Larsen & Lillear 2014	Beyond the field: the impact of farmer field schools on food security and poverty allevation	World Development	Tanzania	FFS	Quantitative evaluation: DiD	Uptake of proposed technology options, i.e. crops, poultry breeds, goat breeds; development outcomes, i.e. frequency of meat and egg consumption	Yes
34	Lund et al. 2010	Farmer field school-IPM impacts on urban and peri-urban vegetable producers	International Journal of Tropical Insect Science	Benin	FFS	Quantitative evaluation: DiD	pesticide use; knowledge acquisition; adoption of integrated pest management options	Yes

		in cotonau, Benin						
35	Mancini et al. 2007	Evaluating cotton integrated pest management (IPM) farmer field school outcomes using the sustainable livelihoods approach in India	Experimental Agriculture	India	FFS	Quantitative evaluation: NCIA	Capital stocks: respondents were asked to value their capital stocks (natural, social, human, physical and financial capital) on a scale from 0 (no stock) to 5.	No, there is measurement over time, but with help of recall data
36	Mancini & Jiggins 2008	Appraisal of methods to evaluate farmer field schools	Development in Practice	India	FFS	Quantitative evaluation: DiD	ecological footprint; occupational hazard of cotton production; effects of integrated pest management adoption on labour allocation; management practices and livelihood	Yes
37	Mariyono et al. 2013	Farmer field schools on Chili Peppers in Aceh, Indonesia: activities and impacts	Agroecology and Sustainable Food Systems	Indonesia	FFS	Quantitative evaluation: Not explicitly mentioned, but shows similarities to DiD	knowledge acquisition	No, they assume an equal baseline for all participants
38								
39	Mataia et al. 2015	Impact of farmer field school - palaycheck in the integrated rice areas	Philippine Journal of Crop Science	Philippines	FFS	Quantitative evaluation: NCIA	Productivity ; yield	Yes, but do not include a control group. Only measure difference over time for

		in the Philippines						treatment group.
	Mauceri et al. 2007	Effectiveness of integrated pest management dissemination techniques: a case study of potato farmers in Carchi, Ecuador	Journal of Agricultural and Applied Economics	Ecuador	FFS	Quantitative evaluation: IV	Knowledge acquisition; knowledge adoption	No
40	Mfitumukiza et al. 2017	Assessing the farmer field school's diffusion of knowledge and adaptation to climate change by smallholder farmers in Kiboga District, Uganda	Journal of Agricultural Extension and Rural Development	Uganda	FFS	Quantitative evaluation: NCIA	Knowledge diffusion; uptake of climate change adaptation measures	No
41	Moumani-Helali & Ahmadpour 2013	Impact of farmer's field school approach on knowledge, attitude and adoption of rice producers toward biological control: the case of Babol Townships, Iran	World Applied Sciences Journal	Iran	FFS	Quantitative evaluation: NCIA	Knowledge acquisition; knowledge adoption	No
42	Mutandwa & Mpangwa 2004	An assessment of the impact of farmer field schools on integrated pest manageme	Journal of Sustainable Development in Africa	Zimbabwe	FFS	Quantitative evaluation: NCIA	Knowledge acquisition; income	Yes

		nt disseminat ion and use: evidence from small holder cotton farmers in the Lowveld area of zimbabwe						
43	Olanya et al. 2010	Comparati ve assessment of pest manageme nt practices in potato production at farmer field schools	Food Security	Uganda	FFS	Quantita tive evaluati on: NCIA	Knowledge acquisition; late blight development ; perceptions of pest management and agronomic practices	Yes
44	Pamuk et al. 2014	Do decentraliz ed innovation systems promote agricultura l technology adoption? Experimen tal evidence from Africa	Food Policy	Several regions in Africa	Innovation platform (programm e name: Sub-Sahara African Challenge Program)	Quantita tive evaluati on: DiD	Adoption of innovations relating to soil and water management , soil fertility management , crop management , post-harvest storage	Yes
45	Pamuk et al. 2015	Decentrali sed innovation systems and poverty reduction: experiment al evidence from Central Africa	European Review of Agricultu ral Economic s	Rwand a; Uganda	Innovation platform	Quantita tive evaluati on: DiD	Poverty alleviation; food consumption	Yes
46	Pedzisa et al. 2010	An evaluation of the use of participato ry processes in wide-scale disseminat ion of	Research Evaluatio n	Zimbab we	Participato ry action research	Quantita tive evaluati on: NCIA	Adoption of innovations relating to fertilizer use, nutrient management , tillage and mulching	No

		research in micro dosing and conservation agriculture in Zimbabwe						
47	Prager & Creaney 2017	Achieving on-farm practice change through facilitated group learning: evaluating the effectiveness of monitor farms and discussion groups	Journal of Rural Studies	Ireland and Scotland	Discussion groups; monitor farms	Qualitative evaluation	Qualitative assessment of the levels of learning, knowledge exchange and practice change	No
48	Rahman & Hamid 2012	Impact of FFS on farmers' adoption of IPM options for tomato: a case study from the Gezira State, Sudan	International Journal of Development and Sustainability	Sudan	FFS	Quantitative evaluation: NCIA	Adoption of practices: land preparation; sewing methods; fertiliser use; intercropping; use of soft chemicals; weed control; irrigation; stoppage of spraying pesticides at 50% fruit setting	No
49	Rejesus et al. 2009	The impact of integrated pest management information dessimination methods on insecticide use and efficiency: evidence from rice producers	Review of Agricultural Economics	Vietnam	FFS	Quantitative evaluation: Heckman estimator	Pesticide use; efficiency	No

		in South Vietnam						
50	Rejesus et al. 2012	Sending vietnamese rice farmers back to school: further evidence on the impact of farmer field schools	Canadian Journal of Agricultural Economics	Vietnam	FFS	Quantitative evaluation: DiD	Yield; pesticide use; knowledge acquisition	Yes
51	Ricker-Gilbert et al. 2008	Cost-effectiveness of alternative integrated pest management extension methods: an example from Bangladesh	Review of Agricultural Economics	Bangladesh	FFS	Quantitative evaluation: IV	Knowledge acquisition; knowledge dissemination	No
52	Rodriguez et al. 2007	Impacts of an agricultural development program for poor coconut producers in the Philippines: an approach using panel data and propensity score matching technique	Journal of Agricultural and Resource Economics	Philippines	Farmer training groups (part of MAUNLAD programme)	Quantitative evaluation; PSM and DiD	Income	Yes
53	Rola et al. 2002	Do farmer field school graduates retain and share what they learn? An investigation in	Journal of International Agricultural and Extension Education	Philippines	FFS	Quantitative evaluation: NCIA	Knowledge acquisition; knowledge diffusion	No, but use data collected by a study of Rola et al. 1998

		Illoilo, Philippines						
54	Roche et al. 2015	Evaluating the effect of focus farms on Ontario dairy producers' knowedge, attitudes, and behaviour toward control of Johne's Disease	Journal of Dairy Science	Canada	Participatory-based experimental learning programme (Programme name: Ontario Focus Farms)	Quantitative evaluation: NCIA	Knowledge acquisition; attitudes; behaviour	Yes
55	Roy et al. 2015	Effectiveness of farmer field school for soil and crop management	International Journal of Sciences: Basic and Applied Research	Bangladesh	FFS	Quantitative evaluation: NCIA	Perception of farmers on programme	No
56	Rustam et al. 2010	Effect of integrated pest management farmer field school (IPMFFS) on farmers' knowledge, farmers groups' ability, process of adoption and diffusion of IPM in Jember district	Journal of Agricultural Extension and Rural Development	Indonesia	FFS	Quantitative evaluation: NCIA	Knowledge diffusion; knowledge acquisition	Partly, there is a baseline study, but contains not all indicators
57	Schreinemachers et al. 2016	Farmer training in off-season vegetables: effects on income and pesticide use in Bangladesh	Food Policy	Bangladesh	Farmer training	Quantitative evaluation: PSM	Crop output; land productivity; farm profit; total per capita income; pesticide use	No
58	Sharma et al. 2015	Quantitative evaluation	Crop Protection	India	FFS	Quantitative evaluati	Pesticide use	No

		indicators of an integrated pest management program in vegetable crops in the subtropical region of Jammu and Kashmir, India				on: NCIA		
59	Sharma & Peshin 2016	Impact of integrated pest management of vegetables on pesticide use in subtropical Jammu, India	Crop Protection	India	FFS	Quantitative evaluation: DiD	Pesticide use	Yes
60	Siddiqui et al. 2012	Assessing the impact of integrated pest management farmer field schools (IPM-FFSs) on acquisition of farmers' knowledge regarding use of pesticide, nutrient management and confidence in decision making process	Pakistan Journal of Life and Social Sciences	Pakistan	FFS	Quantitative evaluation: NCIA	knowledge acquisition	No
61	Snapp et al. 2002	Farmer and researcher partnerships in Malawi: developing soil fertility technologies for the	Experimental Agriculture	Malawi	Participatory action research	Quantitative evaluation: NCIA	Productivity; farmer perceptions; economic performance	Yes

		near-term and far-term						
62	Tamini et al. 2011	A nonparametric analysis of the impact of agri-environmental advisory activities on best management practice adoption: a case study of Quebec	Ecological Economics	Canada	Farmer advisory clubs	Quantitative evaluation: IV	Adoption of best management practices: use of mineral fertiliser; hydraulic infrastructure; conservation tillage; riparian buffer	No
63	Tin et al. 2010	Increase of farmers' knowledge through farmer seed production schools in Viernam as assessed on the basis of ex-ante and ex-post tests	The Journal of Agricultural Education and Extension	Vietnam	FFS	Quantitative evaluation: NCIA	Knowledge acquisition	Yes
64	Todo & Takahaski 2013	Impact of farmer field schools on agriculture income and skills: evidence from an aid-funded project in rural Ethiopia	Journal of International Development	Ethiopia	FFS	Quantitative evaluation: PSM and DiD	Income	No
65	Togbé et al. 2014	Effect of participatory research on farmers' knowledge and practice of IPM: The case of cotton in Benin	The Journal of Agricultural Education and Extension	Benin	FFS	Quantitative evaluation: DiD	Knowledge acquisition; pesticide use	Yes
66	Vaarst et al. 2007	Participatory	Tropical Animal	Uganda	Participatory farmer	Qualitative	Improved practices:	No

		livestock farmer training for improvement of animal health ini rural and peri-urban smallholder dairy herds in Jinja, Uganda	Health and Production		training groups (based on FFS approach)	evaluation	increased milk production; reduction of Mastitis incidence	
67	Wafula et al. 2016	Does strengthening technical capacity of smallholder farmers enhance adoption of conservation practices? The case of conservation agriculture with trees in Kenya	Agroforestry Systems	Kenya	Participatory farmer training groups	Quantitative evaluation: IV	Uptake of conservation agriculture technology	No
68	Witt et al. 2008	The farmer field school in Senegal. Does training intensity affect diffusion of information?	Journal of International Agricultural and Extension Education	Senegal	FFS	Quantitative evaluation: NCIA	Knowledge diffusion	No
69	Yamazaki & Resosuderm o 2008	Does sending farmers back to school have an impact? Revising the issue	The Developing Economies	Indonesia	FFS	Quantitative evaluation: DiD	knowledge acquisition; knowledge diffusion	Yes
70	Yang et al. 2008	Effects of training on acquisition of pest management knowledge	Crop Protection	China	FFS	Quantitative evaluation: DiD	knowledge acquisition; skills	Yes

		and skills by small vegetable farmers						
71	Yorobe et al. 2011	Insecticide use impacts of integrated pest management (IPM) farmer field schools: evidence from onion farmers in the Philippines	Agricultural Systems	Philippines	FFS	Quantitative evaluation: IV	Insecticide use	No

Appendix B. Supplementary material for Paper 2

1. The survey questions for the quantitative evaluation. Only the parts used for this evaluation are included in this appendix.

READ OUT TO RESPONDENT: I would like to invite you to participate in a phone survey conducted by xxx, also known as xxx, which will be carried out by professional interviewers from xxx. The survey seeks to improve our understanding of the implementation of environmental measures in agriculture. This survey is aimed at farmers or farm managers who are involved in the main on-farm decision-making. The survey lasts 20 min, but before I can start the survey I would like to ask you two questions to make sure you are part of the group of farmers we are targeting.

INSTRUCTION INTERVIEWER: CHECK IF RESPONDENT HAS TIME TO PROCEED WITH THE INTERVIEW. OTHERWISE OFFER OPTION TO CALL BACK AT A LATER TIME.

SECTION 1. GENERAL QUESTIONS BEFORE INITIATION OF THE SURVEY

Q.1 Are you a farmer, farm manager or crofter? SINGLE CODE

INSTRUCTION INTERVIEWER: WHEN RESPONDENT ANSWERS 'FARMER' (OR FARMER'S WIFE), 'FARM MANAGER' OR 'CROFTER' THEN CODE 'YES'

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF RESPONSE IS YES (CODE 1) CONTINUE WITH SURVEY. OTHERWISE THANK THE RESPONDENT AND ASK FOR CONTACT INFORMATION OF THE MAIN DECISION-MAKER (THE PERSON WHO IS RESPONSIBLE FOR MOST LONG TERM DECISIONS): Unfortunately, this survey is designed to be completed by the person who is a farmer, farm manager or crofter.

Q.2 Are you involved in the main decision-making on the farm? SINGLE CODE

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF RESPONSE IS NO (CODE 2) THANK THE PARTICIPANT AND ASK FOR CONTACT INFORMATION OF THE MAIN DECISION-MAKER IN Q2B: Unfortunately, this survey is designed to be completed by the person who is involved in most of the long-term planning decisions.

Q.2B Is someone else in your household responsible for the long-term decision making?

Yes → would it be possible to contact this person now or at a later point in time? (or at a different number)

PROBE INTERVIEWER: THE MAIN DECISION MAKER MIGHT LIVE IN THE SAME HOUSEHOLD, THEREFORE ASK WHETHER IT IS POSSIBLE TO CONTACT VIA THE SAME NUMBER AT A DIFFERENT TIME, OR WHETHER IT IS EASIER TO CONTACT THIS PERSON AT A DIFFERENT PHONE NUMBER

No → Could provide that person's contact information so we can invite him or her to participate in the survey?

Name …….

Telephone number……..

IF RESPONSE IS YES (CODE 1) CONTINUE WITH SURVEY. READ OUT TO RESPONDENT: Thank you for agreeing to participate in our survey. Your answers will remain strictly confidential and no individual farmer will be identified as having participated in this research. You are free to stop participation or refuse to answer a question at any time. There is no wrong or right answer and if you do not know the answer to a question, you can always respond with 'don't know' or if the question is not applicable to your situation, you can always answer with 'not applicable'.

SECTION 3. PEP QUESTIONS

INTERVIEWER READ OUT: I would now like to ask you questions about Focus Farm discussion meetings organised by xxx.

Q.8 Have you ever participated in xxx discussion meetings organised xxx? SINGLE CODE

Yes	1
No	2
Don't know	98
REFUSED TO ANSWER	99

IF YES (CODE 1), PROCEED TO Q.9. IF NO (CODE 2) OR DON'T KNOW (CODE 98), PROCEED TO Q.11

INTERVIEWER READ OUT: in the following questions I will refer to xxx as 'focus farm meetings'

Q.9 Approximately how many times have you attended Focus Farm meetings since 2010? Would you say once, 2-3 times or more than 3 times? SINGLE CODE

Once	1
2-3 times	2
More than 3 times	3
NEVER	97
DON'T KNOW	98
REFUSED TO ANSWER	99

PROBE INTERVIEWER WHEN RESPONSE (SPONTANEOUS) IS 'NEVER' (CODE 4): You indicated in the previous question that you have attended climate change focus farm discussion meetings, are you sure your answer is 'never'? IF YES, GO BACK TO Q.8 AND CHANGE ANSWER. THEN CONTINUE Q.11. IF NO, ASK Q.9 AGAIN AND CONTINUE WITH Q.10.

READ OUT TO RESPONDENT: I will be reading out a number of questions about the focus farm meetings. Please provide an answer to these questions with 'yes' or 'no'.

THE INTERVIEWER DOES NOT NEED TO READ OUT THE ANSWERS 'YES', 'NO' AND 'DON'T KNOW' FOR EACH QUESTION. READ OUT FOR AT LEAST THE FIRST TWO QUESTIONS AND THEN ONLY READ OUT ANSWER OPTIONS WHEN A RESPONDENT FORGETS OR GIVES A DIFFERENT RESPONSE

INSTRUCTION INTERVIEWER FOR ALL Q.6: IF RESPONSE IS 'SOMETIMES', 'OFTEN' OR A SIMILAR TERM, PLEASE PROBE THE RESPONDENT AND ASK FOR A 'YES' OR 'NO'. IF THE RESPONDENT STAYS WITH HIS ANSWER YOU CAN CODE 'SOMETIMES' OR 'OFTEN' AS 'YES' (CODE 1). IF RESPONSE IS 'RARELY' CODE AS 'NO' (CODE 2)

Q.10a Have you discussed the changes suggested during focus farm meetings with farmers who did not attend the meetings?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.10b Have you sought advice from peers or experts whom you have met at focus farm meetings?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.10c Were you aware of climate change mitigation measures you could implement on farm before participation in the focus farm meetings?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.10d - 1 Have you implemented changes suggested during focus farm meetings on your farm?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE TO 10.D-2. OTHERWISE CONTINUE WITH Q.11

INTERVIEWER READ OUT: I would like to ask you about the change or changes you have implemented. I will be reading out five key areas of the PEP programme and please identify with either 'yes' or 'no' whether you have implemented changes in this area.

Q.10d – 2 Locking carbon on the farm?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.10d – 3 Developing renewable energy?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.10d – 4 Using energy and fuel efficiently?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.10d – 5 Optimising livestock performance?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99
NOT APPLICABLE	5 (in survey doc)

Q.10d – 6 Soil, fertiliser and manure management?

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

SECTION 4. IMPACT INDICATORS

4.1 KNOWLEDGE TEST

READ OUT TO RESPONDENT: I will read out 6 questions about environmentally friendly farm practices. Please answer the question with either 'yes' or 'no'.

NOTE TO INTERVIEWER: THERE IS NO NEED TO READ OUT THE ANSWER OPTIONS 'YES' OR 'NO' FOR EACH QUESTION. READ OUT FOR AT LEAST THE FIRST TWO QUESTIONS AND THEN ONLY TO READ OUT THE ANSWER OPTIONS AGAIN IF THE RESPONDENT DOES NOT REPLY WITH 'YES' OR 'NO'.

Q.11a Do you think regularly servicing of heating devices, such as boilers, saves heating costs?

YES	1
NO	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.11b Do you think insulation of heating devices, such as boilers and hot water tanks, is an effective way of decreasing energy usage?

YES	1
NO	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.11c Do you think a carbon footprint of the farm is useful to identify the largest emissions sources?

YES	1
NO	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.11d Do you think the amount of carbon locked on the farm can be increased by changing how existing woodlands are managed?

YES	1
NO	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.11e Do you think the use of cover crops increases nitrate leaching?

YES	1
NO	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.11f Do you think the soil pH is a relevant factor in calculating fertiliser needs?

YES	1
NO	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

4.2 RENEWABLE ENERGY

READ OUT TO RESPONDENT: The upcoming part focuses on the generation of renewable energy on your farm.

Q.12 Do you receive a subsidy for producing renewable energy on your farm?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

READ OUT TO RESPONDENT: I will first ask you questions about the generation of renewable electricity and then about renewable heat.

Q.13 Do you produce renewable electricity on the farm, for instance from wind, solar power, hydro power or biogas?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES CONTINUE WITH Q.14. OTHERWISE CONTINUE WITH Q.19

Q.14a Do you produce renewable electricity from wind?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.14B. OTHERWISE CONTINUE WITH Q.15

Q.14b. How much renewable electricity was generated by this source in 2016? Please express in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.14c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.15a Do you produce renewable electricity from solar energy?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.15B. OTHERWISE CONTINUE WITH Q.16

Q.15b. How much renewable electricity was generated by this source in 2016? Please express in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.15c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.16a Do you produce renewable electricity from hydro power?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.16B. OTHERWISE CONTINUE WITH Q.17

Q.16b. How much renewable electricity was generated by this source in 2016? Please express in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.16c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.17a Do you produce renewable electricity from biogas?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.17B. OTHERWISE CONTINUE WITH Q.18

Q.17b. How much renewable electricity was generated by this source in 2016? Please express in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.17c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.18a Do you produce renewable electricity from any other source?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES CONTINUE WITH Q. 18B OTHERWISE CONTINUE WITH Q.19

Q.18b Which source?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.18c How much renewable electricity was generated by this source in 2016? Please express in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.18d In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.19 Do you produce renewable heat on the farm, for example from biogas or wood pellets?

Yes	1
No	2

DON'T KNOW 98
REFUSED TO ANSWER 99

IF YES (CODE 1), CONTINUE WITH Q.20. OTHERWISE CONTINUE WITH Q.25

Q.20a Do you produce renewable heat from wood logs or chips?

Yes 1
No 2
DON'T KNOW 98
REFUSED TO ANSWER 99

IF YES (CODE 1) CONTINUE WITH Q.20B. OTHERWISE CONTINUE WITH Q.21

Q.20b How much renewable heat was produced by this source in 2016? Please express this amount in kWh.

_____

DON'T KNOW 98
REFUSED TO ANSWER 99

Q.20c. In which year was this source implemented on your farm?

_____

DON'T KNOW 98
REFUSED TO ANSWER 99

Q.21a Do you produce renewable heat from wood pellets?

Yes 1
No 2
DON'T KNOW 98
REFUSED TO ANSWER 99

IF YES (CODE 1) CONTINUE WITH Q.21B. OTHERWISE CONTINUE WITH Q.22

Q.21b How much renewable heat was produced by this source in 2016? Please express this amount in kWh.

_____

DON'T KNOW 98
REFUSED TO ANSWER 99

Q.21c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.22a Do you produce renewable heat from grass or straw?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.22B. OTHERWISE CONTINUE WITH Q.23

Q.22b How much renewable heat was produced by this source in 2016? Please express this amount in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.22c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.23a Do you produce renewable heat from biogas?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.23B. OTHERWISE CONTINUE WITH Q.24

Q.23b How much renewable heat was produced by this source in 2016? Please express this amount in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.23c. In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.24a Do you produce renewable heat from any other source?

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES CONTINUE WITH Q. 24B OTHERWISE CONTINUE WITH Q.25

Q.24b Which source?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.24c How much renewable heat was produced by this source in 2016? Please express in kWh.

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.24d In which year was this source implemented on your farm?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

4.3 SOIL NUTRIENT AND ANIMAL MANAGEMENT

READ OUT TO RESPONDENT: I will now ask you some questions about soil nutrient and animal management.

Q.25 Do you conduct soil testing on your fields? SINGLE CODE.

Yes	1
No	2
NOT APPLICABLE	96

DON'T KNOW 98
REFUSED TO ANSWER 99

CONTINUE AT Q.26 IF YES (CODE 1). OTHERWISE CONTINUE WITH Q.28

Q.26 How often do you on average conduct soil testing on your fields (Not including rough/mountain grazing and any common land from your estimation)? Would you say yearly, every 2-5 years, or every 6 years or less often? SINGLE CODE.

Yearly 1
Every 2 to 5 years 2
Every 6 years or less often 3
DON'T KNOW 98
REFUSED TO ANSWER 99

Q.27 What proportion of your farm did you have soil tested in the past 5 years (exclude rough/mountain grazing and any common land from your estimation)? Would you say less than 25%, 25-75 %, or more than 75 %? SINGLE CODE

Less than 25% 1
25 to 75% 2
More than 75% 3
DON'T KNOW 98
REFUSED TO ANSWER 99

INTERVIEWER READ OUT: Before asking the next questions, I would like to mention that a nutrient management plan is also known as a fertiliser plan or NMP. This plan can be developed individually or with an advisor and can tell you generally on which fields fertiliser is needed and in what quantities.

Q.28 Do you have a nutrient management plan? SINGLE CODE

Yes 1
No 2
NOT APPLICABLE 96
DON'T KNOW 98
REFUSED TO ANSWER 99

IF YES (CODE 1) AT Q.28 CONTINUE WITH Q.29. All OTHERS PROCEED TO Q.32

Q.29 Who created your formally developed nutrient management plan? Would that be yourself, an advisor, yourself together with an advisor or someone else? SINGLE CODE

Myself	1
An advisor	2
Myself and an advisor	3
Other	4
DON'T KNOW	98
REFUSED TO ANSWER	99

WHEN RESPONSE IS 'MYSELF' (CODE 1) OR 'MYSELF AND AN ADVISOR (CODE 3) THEN CONTINUE WITH Q.30, OTHERWISE PROCEED TO Q.31

INTERVIEWER READ OUT: I will read out different information tools. Please identify if you use these tools in the development of your management plan by responding 'yes' or 'no'.

INSTRUCTION: THE INTERVIEWER DOES NOT NEED TO READ OUT THE ANSWERS 'YES' AND 'NO' FOR EACH QUESTION. ONLY READ OUT THE STATEMENT AND REMEMBER THE PARTICIPANT THEY CAN ANSWER 'YES', 'NO' OR 'DON'T KNOW' TO A QUESTION WHEN THEY FORGET OR GIVE A DIFFERENT RESPONSE

30a PLANET? SINGLE CODE

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

30b xxx technical notes? SINGLE CODE

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

30c GPS mapping? SINGLE CODE

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

30d Any other information tool? SINGLE CODE

YES	1
NO	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE TO Q.30D-2. OTHERWISE CONTINUE WITH Q.31

30D-2 Which information tool(s)?

_____

Q.31 Do you apply manure or slurry on your farm? SINGLE CODE

Yes	1
No	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.32. OTHERWISE CONTINUE WITH Q.34

Q.32 What method do you use to apply manure or slurry? Do you 1: inject it into the soil, 2: band spread it by training hose or shoe, or 3: broadcast? MULTI CODE

Inject into the soil	1
Band spread by training horse or shoe	2
Broadcast	3
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.33 How soon after application would you typically plough in manure or slurry? Would you say within 4 hours, between 5 and 6 hours, or after more than 6 hours? SINGLE CODE

Within 4 hours	1
Between 5 and 6 hours	2
After more than 6 hours	3
DON'T KNOW	98
REFUSED TO ANSWER	99
NOT APPLICABLE	6 (in survey data)

INTERVIEWER READ OUT: Variable rate application techniques are a precision farming tool. The techniques are used for application of material, such as fertiliser or lime, in a way that the rate of application is based on the precise location of the area that the material is being applied to.

Q.34 Do you use variable rate application techniques when applying nitrogen fertiliser or lime? SINGLE CODE

Yes	1
No	2
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.35 Do you conduct arable farming on your farm? SINGLE CODE

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES, CONTINUE WITH Q.36. OTHERWISE CONTINUE WITH Q.37

Q.36 Do you include legumes in your crop rotations? SINGLE CODE

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE WITH Q.36B. OTHERWISE CONTINUE WITH 37.

Q.36b How often do you include legumes in your crop rotations? Would you say yearly, every 2 to 5 years or every 6 years or less often? SINGLE CODE

Yearly	1
Every 2 – 5 years	2
Every 6 years or less often	3
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.37 Do you have animals on your farm? SINGLE CODE

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF YES (CODE 1) CONTINUE TO Q.37B. OTHERWISE CONTINUE WITH Q.42

Q.37b I will now read out different enterprises. Please estimate the total number of animals on your farm in 2017 per enterprise. MULTICODING ALLOWED, E.G. FARMER CAN OWN DIFFERENT TYPE OF ANIMALS

Dairy?	
Beef ?	
Sheep?	
Other?	

Q.38a Do you use a mix containing red clover when you reseed your grassland? SINGLE CODE

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99
NOT APPLICABLE	5 (in survey)

Q.38b Do you use a mix containing white clover when you reseed your grassland? SINGLE CODE

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99
NOT APPLICABLE	5 (in survey)

Q.39 Do you have a herd health plan? SINGLE CODE

Yes	1
No	2

NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.40 How often do you consult a vet for non-essential check-ups of your livestock? Would you say never, at least every 6 months, every 7 to 12 months, or less often than annually? SINGLE CODE

At least every 6 months	1
every 7 to 12 months	2
Less often than annually	3
NOT APPLICABLE	96
Never	97
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.41 When making decisions on breeding stock, including bull, tup or ram hire, would you say you mainly base your decision on estimated breeding value, preferred traits, costs, or intuition? MULTI CODE

Estimated breeding value	1
Preferred traits	2
Intuition	3
Cost	4
NOT APPLICABLE	96
DON'T KNOW	98
REFUSED TO ANSWER	99

SECTION 5. FARM AND FARMER CHARACTERISTICS

READ OUT TO RESPONDENT: We have reached the final section of the survey. I will now ask you some questions about the characteristics of you and your farm. I will start with your characteristics and then continue with the characteristics of the farm.

Q.42 What is your age? SINGLE CODE

INSTRUCTION INTERVIEWER Q.42: DO NOT READ OUT THE AGE BANDS, BUT CIRCLE THE AGE CATEGORY THE PARTICIPANT FALLS INTO. IF THEY DO NOT WANT TO SHARE THEIR AGE DIRECTLY, THEN READ OUT AGE BANDS.

UNDER 25 1
25-34 2
35-39 3
40-44 4
45-54 5
55-64 6
65 AND OVER 7
DON'T KNOW 98
REFUSED TO ANSWER 99

Q.43 How many years have you been farming?

INSTRUCTION INTERVIEWER Q.43: DO NOT READ OUT THE BANDS, BUT CIRCLE THE CATEGORY THE PARTICIPANT FALLS INTO

LESS THAN 10 YEARS	1
10 TO 20 YEARS	2
21 TO 30 YEARS	3
MORE THAN 30 YEARS	4
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.44 What describes the highest level of training undertaken? Would you say you have 1: practical agricultural experience only, 2: less than 2 years basic agricultural training, or 3: a full agricultural training course of 2 years or more? SINGLE CODE

Practical agricultural experience only 1
Basic agricultural training course – less than 2 years long 2
Full agricultural training course – 2 years long or more 3
DON'T KNOW 98
REFUSED TO ANSWER 99

INTERVIEWER READ OUT: I will now continue with asking about characteristics of your farm.

Q.45 What is the total number of hectares or acres farmed by you in 2017? [This includes rented or leased land] SINGLE CODE

____ ha or ____ac

INSTRUCTION INTERVIEWER: IF THEY DO NOT WANT TO MENTION THE EXACT NUMBER, PLEASE READ OUT AREA BANDS

LESS THAN 10 HA (25 ACRES) 1
10-19 HA (25-50 ACRES)……..... ... 2
20-49 HA (50-123 ACRES)..... 3
50-99 HA (123-247 ACRES) 4
100-149 HA (247-370 ACRES)..... 5
150 HA OR MORE (370 + ACRES) 6
DON'T KNOW..... 98
REFUSED TO ANSWER..... 99

Q.46 Is any of this land leased or rented from others? SINGLE CODE

Yes 1
No..... 2
DON'T KNOW..... 98
REFUSED TO ANSWER..... 99

IF YES, PROCEED TO Q.47 OTHERWISE CONTINUE WITH Q.48.

Q.47 What is the total number of hectares or acres you rented from others?

____ha or ____ac

INSTRUCTION INTERVIEWER: IF THEY DO NOT WANT TO MENTION THE EXACT NUMBER, PLEASE READ OUT AREA BANDS

LESS THAN 10 HA (25 ACRES) 1
10-19 HA (25-50 ACRES)……..... 2
20-49 HA (50-123 ACRES)..... 3
50-99 HA (123-247 ACRES) 4
100-149 HA (247-370 ACRES)..... 5
150 HA OR MORE (370 + ACRES) 6
DON'T KNOW..... 98
REFUSED TO ANSWER..... 99

Q.48 Have you identified a successor to take over the farm? SINGLE CODE

Yes 1
No..... 2
DON'T KNOW..... 98
REFUSED TO ANSWER..... 99

Q.49 Which of the following terms best describes the soil type of most of your land? Would you say 1: no limitations and suitable for a wide range of agricultural uses, 2: somewhat limited by for instance poor drainage or altitude or 3: very limited by for instance mountain areas? SINGLE CODE

Suitable for a wide range of agricultural uses 1
Somewhat limited e.g. by poor drainage or altitude 2
Very limited for agriculture e.g. mountain areas 3
DON'T KNOW..... 98
REFUSED TO ANSWER..... 99

Q.50 Which of the following most closely reflects your major farm activity? Would you say 1: mainly dairying, 2: mainly beef, 3: mainly sheep, 4: mainly arable, 5: mixed livestock, 6: mainly forage or 7: mixed farm? SINGLE CODE

Mainly dairying 1
Mainly beef 2
Mainly sheep 3
Mainly arable 4
Mainly mixed livestock..... 5
Mainly forage..... 6
Mixed farm..... 7
DON'T KNOW..... 98
REFUSED TO ANSWER..... 99

Q.51 I would like to ask for your approximate annual farm income before taxes. Please do not include the household income. SINGLE CODE

Q.51a Is it below or above £30,000 per annum (£580 per week)?

BELOW	1
ABOVE	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF BELOW (CODE 1) CONTINUE WITH Q.51B. IF ABOVE (CODE 2) CONTINUE WITH Q.51D.

Q.51b Is it below or above £20,000 per annum (£385 per week)?

BELOW	1
ABOVE	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF BELOW (CODE 2) CONTINUE WITH Q.51C. IF ABOVE (CODE 2) CONTINUE WITH Q.52

Q.51c Is it below or above £10,000 per annum (£195 per week)?

BELOW	1
ABOVE	2
DON'T KNOW	98
REFUSED TO ANSWER	99

FOR BELOW AND ABOVE (CODE 1 AND 2) CONTINUE TO Q.52

Q.51d Is it below or above £40,000 per annum (£770 per week)

BELOW	1
ABOVE	2
DON'T KNOW	98
REFUSED TO ANSWER	99

IF BELOW (CODE 1) CONTINUE WITH Q.52. IF ABOVE (CODE 2) CONTINUE WITH Q.51E

Q.51e Is it below or above £50,000 per annum (£960 per week)

BELOW	1
ABOVE	2
DON'T KNOW	98
REFUSED TO ANSWER	99

Q.52 What is the agricultural holding number of your farm? INSTRUCTION INTERVIEWER: MOST FARMERS WILL NOT MENTION THE FIRST TWO DIGITS AND THE CODES MAY DIFFER IN LENGTH, SO NOT ALL THE 9 DIGITS WILL BE MENTIONED.

_ _ / _ _ _ / _ _ _ _

DON'T KNOW	98
REFUSED TO ANSWER	99

Q.53 What is your post code?

_____

DON'T KNOW	98
REFUSED TO ANSWER	99

INTERVIEWER READ OUT: Thank you for participating in our survey. In the future we might like to conduct follow-up research, therefore I would like to ask whether you are willing to participate in a follow-up survey? SINGLE CODE

Q.54

Yes	1
No	2
DON'T KNOW	98
REFUSED TO ANSWER	99

INTERVIEWER READ OUT: This is the end of the survey. Thank you for participating.

INSTRUCTION TO INTERVIEWER: AFTER EACH INTERVIEW NOTE DOWN THE FOLLOWING (DO NOT ASK THIS TO THE RESPONDENT):

Extra details respondent	Answer
Caller ID of respondent	
Gender of respondent	
Number of attempt	
Duration of the interview in minutes and seconds	
Starting time of the interview	
Date the interview took place	

2. Overview of the respondents included in the interviews of Paper 2.

Table 7. Overview of the 20 respondents included in the interviews of Paper 2.

Respondent	Area	Years of experience	Agricultural education	Size of farm (ha)	Rented land (yes/no)	Successor (yes/no)	Soil type	Type of farm	Nr of meetings (as indicated in survey)	Nr of meetings (as indicated in interview
1	Scottish borders	>30	Yes (full)	194	no	yes	very limited	mixed farm	>3	>3
2	Scottish borders	>30	Yes (full)	500	no	no	suitable	mixed livestock	>3	>3
3	East Lothian	21-30	Yes (full)	170	yes	no	limited	arable	>3	>3
4	Angus	>30	Yes (full)	165	no	yes	suitable	arable	>3	>3
5	Angus	>30	Yes (full)	300	no	no	suitable	arable	2 to 3	?
6	Aberdeenshire	21-30	Yes (full)	15	yes	yes	limited	mixed livestock	2 to 3	2 to 3
7	Aberdeenshire	21-30	Yes (full)	29	no	no	limited	arable	2 to 3	?
8	Aberdeenshire	>30	no (practical experience)	202	no	yes	suitable	mixed farm	2 to 3	2 to 3
9	Aberdeenshire	>30	Yes (full)	60	no	no	limited	forage	>3	>3
10	East Ayrshire	>30	Yes (full)	220	yes	yes	limited	mixed livestock	>3	>3
11	East Ayrshire	21-30	Yes (full)	240	yes	no	limited	dairy	2 to 3	2 to 3

12	Dumfries and Galloway	21-30	Yes (basic)	52	no	no	suitable	forage	>3	>3
13	Stirling	>30	Yes (full)	160	no	yes	limited	dairy	>3	?
14	Fife	21-30	Yes (basic)	242	yes	no	limited	mixed farm	2 to 3	2 to 3
15	Aberdeenshire	21-30	Yes (basic)	2226	yes	no	limited	mixed farm	>3	2 to 3
16	Aberdeenshire	21-30	Yes (full)	53	yes	no	suitable	mixed farm	>3	>3
17	Aberdeenshire	>30	Yes (full)	440	yes	no	limited	beef	2 to 3	2 to 3
18	Fife	21-30	Yes (full)	250	yes	yes	suitable	dairy	>3	>3
19	Midlothian	21-30	yes (full)	11000	yes	no	suitable	mixed farm	>3	2 to 3
20	Eastlothian	>30	yes (full)	360	no	yes	suitable	mixed farm	2 to 3	?

3. Overview of the questionnaire used for the qualitative analysis

- Could you please describe your role on the farm?
- How would you describe your type of farm?
- How many ha is the farm you are farming on? (how much is owned/how much is leased?)
- how many employees do you have?
- What is the herd size?
- Are you a member of a farming group? E.g. discussion groups
    - for each of the groups mentioned: how often have you met them over the past year?
- How would you describe your experience working on this specific farm and in the farming sector in general?
- How would you describe the management of the farm (governance)?
    - if multiple people are involved in management: who is responsible for which decision-making?
- How much longer do you intend to be on the property?
    - Do you have a successor?
- Do you receive any subsidies?
    - if yes, what type of subsidies? (e.g. based on voluntary participation etc.)
- What are your goals/aspirations for the farm?
    - Are these any different to what they were 5-10 years ago?

I would like to gain insight into how you have experienced meetings of the PEP.

- Which focus farm did you visit mostly?
- Can you describe how you have experienced your participation in the programme?
- Can you describe why you attended the meetings?
- About the structure of the meeting:
    - Can you describe what the meetings looked like?
    - Did you have the opportunity to raise your own issues or share experiences?
    - Did you have discussion at the meeting in small groups?
- About peers

    - Please describe the nature of the interaction with peers during the meetings?
    - Did you know any of the other participants of the meeting?
    - Have you met with any other farmers at the meetings more than once?
    - What type of information did you share about your farm? What did others share?
    - Did you discuss with any of your peers outside the meetings?
- About the facilitator
    - Please describe the nature of the interaction with the facilitator during the meetings?
    - Would you consider going to meetings with the same facilitator again? Why?
    - Would you take up changes if recommended by the facilitator?
- About the experts
    - Please describe the nature of the interaction with the experts during the meetings?
    - How credible was the information presented by the experts?
- About how they feel their thinking has changed
    - To what extent did participating change your concerns about the topics discussed?
    - The most interesting thoughts were rather from peers, or the facilitator, or the experts?
    - Have you experimented with any of the suggested practices?
    - Can you name any other changes you have made due to participation in the programme?
    - What aspect of the programme stimulated you to make this change?

4. Overview of the data for the quantitative evaluation

Table 8. Variable description and descriptive statistics of the sample before matching. The means and standard deviation are depicted in parentheses. The indicated significance levels in the column 'PEP 2010-2013' indicate differences in covariates between PEP 2010-2013 farmers and control farmers (Comparison I). In the column 'PEP 2014-2017' the differences between PEP 2014-2017 farmers and control farmers are indicated (Comparison II). *,**,* Significant at 0.1%, 1%, 5% level, respectively.**

		Farmer categories		
		PEP 2010-2013 farmers	PEP 2014-2017 farmers	Control farmers
	Description	(n=36)	(n = 114)	(n = 190)
Explanatory variables				
Years of experience	Years of experience as farmer, where 0 = 0 years, 1 = 1 to 10 years, 2 = 11 to 20 years, 3 = 21 to 30 years, 4 = 31 or more	3.30 (1.00)	3.31 (0.98)	3.32 (0.98)
Agricultural education	is 1 if farmer has agricultural education	0.50*** (0.50)	0.55 ***(0.50)	0.44 (0.50)
Size	amount of land (ha) farmed in 2016	303.02 (1688.28)	384.76 (1655.33)	298.37 (1837.30)
Rented land	is 1 if farmer has land rented from others	0.39 (0.49)	0.42* (0.50)	0.38 (0.49)
Successor	is 1 if farmer has a successor	0.41 (0.49)	0.43 (0.50)	0.42 (0.50)
Soil type	is 1 if soil type is limited	0.42 (0.50)	0.47*** (0.50)	0.41 (0.49)
Livestock on farm	is 1 if livestock is present on farm	0.56 (0.50)	0.53 (0.50)	0.56 (0.50)
Outcome variables				
Production of renewable electricity	Is 1 if farmer is producing renewable electricity	0.25*** (0.43)	0.28*** (0.45)	0.20 (0.40)
Production of renewable heat	Is 1 if farmer is producing renewable heat	0.16*** (0.37)	0.17*** (0.38)	0.12 (0.33)
Implementation of nutrient management plan	Is 1 if farmer has implemented a nutrient management plan	0.46 (0.50)	0.59*** (0.49)	0.44 (0.46)
Soil testing	Is 1 if farmer conducts soil testing	0.74*** (0.44)	0.81*** (0.40)	0.69 (0.46)
Knowledge acquisition	Knowledge acquisition measured by amount of questions correctly answered, where 0 represents no questions correctly answered and 6 represents all questions correctly answered	4.52*** (1.13)	4.62*** (1.08)	4.47 (1.12)

Table 9. Propensity score estimates for Comparison I and Comparison II. *,**,* Significant at 0.1%, 1%, 5% level, respectively.**

	Comparison I	Comparison II
Variable		
Years of experience	-0.26 (0.20)	-0.09 (0.13)
Agricultural education	1.63 (0.46) ***	1.18 (0.27) ***
Size	0.00 (0.00)	0.0001 (0.00)
Rented land	0.01 (0.41)	0.24 (0.26)
Successor	-0.33 (0.41)	0.15 (0.26)
Soil type	0.36 (0.39)	0.63 (0.26) *
Livestock	-0.19 (0.40)	-0.52 (0.25) *
Number of observations	226	304
Pseudo R^2	0.094	0.092
Log-likelihood	-89.82	-182.45
LR chi-square	18.58 **	37.32 ***
AIC	195.64	380.91

Table 10. Assessment of matching quality. LR refers to likelihood ratio.

	Comparison I		Comparison II	
	2010-2013	Control	2014-2017	Control
Variable				
Years of experience	3.19	3.22	3.31	3.25
Agricultural education	0.78	0.75	0.73	0.67
Size	327.57	197.22	535.61	401.82
Rented land	0.44	0.47	0.5	0.47
Successor	0.33	0.3	0.44	0.41
Soil type	0.53	0.55	0.56	0.49
Livestock	0.56	0.58	0.48	0.51
Pseudo R^2	0.05		0.01	
LR chi-square	4.95		3.44	

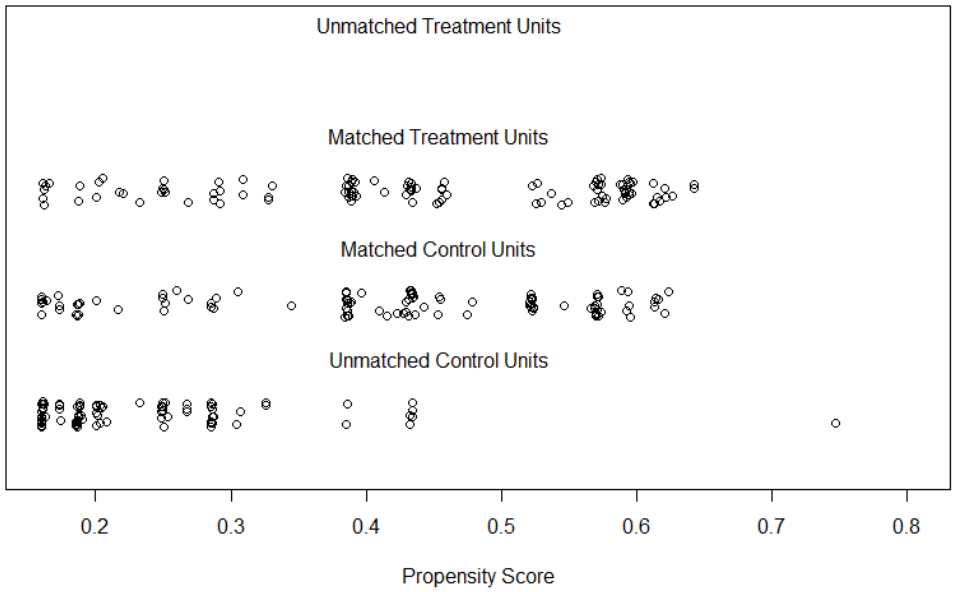

Figure 13. Distribution of the propensity scores between the treatment and control group.

Appendix C. Supplementary material for Paper 3

1. An overview of the interview questions used to explore the factors influencing farmer decision-making regarding water quality issues.

Part 1: Questions regarding background of the interviewee:

- *Could you please describe your role on the farm?*
    - *how many hectares is the farm you are farming on?*
    - *how many employees do you have?*
    - *Optional: What is the herd size?*
- *Are you a member of a farming group? E.g. federated farmers, zone committees?*
    - *For each of the groups mentioned: how often have you met them over the past year?*
- *How would you describe your experience working on this specific farm and in the farming sector in general?*
- *How would you describe the management of the farm?*
    - *If multiple people are involved in management: who is responsible for what decision-making?*
- *How much longer do you intend to be on the property?*
    - *Do you have a successor?*
- *What are your goals/aspirations for the farm?* Brief
    - *Are these any different to what they were 5-10 years ago?*

Part 2:

I would now like to specifically focus on practice changes that are known to be beneficial to the environment.

- *Could you think of any practice changes that you have implemented since 2010 that have contributed to environmentally friendly farm practice?*
    - *Could you give any examples?*
    - *What drove you to implement these particular examples?*
- *If you contemplate on adopting an environmental practice change, what are the information sources (e.g. website, newsletter) you mostly base your decision on?*
    - *If people: what kind of background do these people have?*
    - *Do these people share your goals/aspirations for the farm?*

- *Could you describe specific challenges related to the adoption of environmental practice changes*
    - *If challenges are being identified:*
      What are the causes for these challenges caused?
      How are these challenges addressed?
- *If you decide on adopting a practice change, what are the main motivations to come to that decision? (prompt: build on an example of an earlier discussed environmental practice change)*

2. An overview of the interview questions used to explore the factors influencing farmer decision-making regarding water quality issues.

Table 11. An overview of the data coding structure including quotes, first order concepts and second order concepts.

Example quotes	1st order concepts	2nd order concepts	Dimension
'I think farmers themselves have to find a way of solving it, because they will resist and resent other people telling about it. And that's part of the reason why I have been involved in this aquifer recharge group, because it's the community itself saying 'look we have a problem and we need to find a way through it'. And also I was involved in making an input into plans that are being formed.'	Respondent indicates the importance of community involvement	(outward) system level spatial horizon	Personal
'We're comparing to dairy farms that winter off rather than us wintering on. So if we wintered off, you push that issue to another farm, but it's still your issue, because it's your cows grazing that crop. So even though we're high here, if you drop it down, go somewhere else, you're just taking the issue from here to somewhere else.'	Respondent acknowledges impacts farming may have outside the farm boundaries		
'There is no free rides I mean, you can't have an intensive beef system or be growing crops and putting on heaps of urea and get away with it.'			
'Yeah, we're only caretakers of this land. And you lead by example. So that's what we're trying to do.'	Respondent shows leadership and example		
'So yes, we do need to show leadership, I think as an industry, certainly being part of [cooperation], yes we do definitely.'			
'Short term gain for long term pain does not work. So you want to be able to keep doing something and in a hundred years someone will be too hopefully.'	Respondent indicates the importance of maintaining the farm in good state for future generations	(long term) time horizon	
'Most of the farms, they think in an intergenerational way. So they are thinking about their kids grew up on this farm, and this house, hopefully one day they can take over it. And you can't give your kids an asset that's been devalued or polluted. We're not thinking about that.'			
'I mentioned the destoning and that kind of thing, and I really think that you are only a custodian of the land and I really think that you should leave the land in a better state that you found it, if at all possible.'	Respondent wants to leave the land in better state than it was found		
'[One of the reasons we adopt environmental practices is] to leave it [the farm] in a better state than we found it.'			

3. An overview of the farmers included in the interviews for Paper 3.

Table 12. An overview of the participating farmers for Paper 3, their characteristics and to which type they are allocated.

Respondent	Participant group	Position	Type of farm	Size (ha)	Number of staff (incl. owner)	Age	Family run (yes/no)	Intergenerational (yes/no)	Succession (yes/no/unsure)	Types
1	FRNL	manager	Dairy	353	4	20-30	no	no	n/a	Perpetuate Cooperates
2	FRNL	general manager	Dairy	>1000	40	40-50	no	no	n/a	
3	Network	manager	Dairy	304	4	20-30	no	no	n/a	
4	FRNL	owner-operator	Sheep & Beef	370	2.5	50-60	yes	no	unsure	Enthusiasts
5	FRNL	shared owner-operator	Arable	1400	12	30-40	yes	yes	unsure	
6	FRNL	owner-operator	Arable	500	3	30-40	yes	yes	unsure	
7	FRNL	owner-operator	Sheep & Beef	442	2	40-50	yes	yes	unsure	
8	FRNL	owner-operator	Arable	490	2	60-70	yes	no	no	
9	Network	owner-operator	Sheep & Beef	320	2	50-60	yes	no	yes	
10	Network	owner-operator	Sheep & Beef	1000	2	50-60	yes	yes	unsure	
11	FRNL	equity manager	Dairy	540	9	40-50	no	no	n/a	
12	External	owner	Dairy	230	5	30-40	yes	no	unsure	
13	External	owner-operator	Dairy	928	>6	50-60	yes	yes	yes	

14	Network	owner-operator	Dairy	218	4	50-60	yes	no	yes	
15	External	Owner-operator	Dairy	290	7	40-50	yes	no	unsure	
16	Network	equity-manager	Dairy	200	3	20-30	yes	no	n/a	
17	Network	equity manager	Dairy	840	16	30-40	no	no	n/a	
18	External	equity-manager	Dairy	202	5	50-60	no	no	n/a	
19	External	owner-operator	Arable	350	3	60-70	yes	yes	no	
20	Network	owner-operator	Arable	300	3	40-50	yes	yes	unsure	
21	External	owner-operator	Dairy	406	>6	70-80	yes	yes	yes	
22	External	owner-operator	Arable	225	2	40-50	yes	yes	unsure	
23	External	owner-operator	Sheep & Beef	920	3	30-40	yes	yes	unsure	
24	FRNL	shared owner-operator	Dairy	1400	12	30-40	yes	yes	unsure	Opportunists
25	FRNL	owner-operator	Dairy	650	8	50-60	yes	yes	yes	
26	FRNL	owner-operator	Dairy	823	8	50-60	yes	yes	yes	
27	FRNL	manager	Dairy	310	5.5	30-40	n/a	n/a	n/a	
28	Network	manager	Dairy	314	4	30-40	no	no	n/a	
29	External	owner-operator	Arable	480	3	50-60	yes	yes	yes	

30	Network	owner-operator	Arable	192	2	30-40	yes	no	unsure	
31	Network	shared owner-operator	Sheep & Beef	870	4	20-30	yes	no	unsure	
32	Network	owner-operator	Dairy	268	5	50-60	yes	no	n/a	
33	External	shared owner-operator	Sheep & Beef	930	4	40-50	yes	yes	unsure	
34	External	equity owner farm manager	Dairy	338	5	50-60	no	no	yes	
35	External	owner-operator	Dairy & arable	700	7.5	60-70	yes	yes	yes	
36	External	owner-operator	Arable	210	2	50-60	yes	no	unsure	
37	External	owner-operator	Dairy	365	6	40-50	yes	no	unsure	
38	External	managing director	Dairy	1500	>10	50-60	no	no	yes	
39	External	owner-operator	Arable	200	2	40-50	yes	yes	unsure	
40	External	manager	Dairy	398	5	30-40	yes	yes	no	Bystanders
41	External	owner-operator	Sheep & Beef	482	2	40-50	yes	yes	unsure	
42	Network	owner-operator	Dairy	210	5	30-40	yes	yes	unsure	
43	Network	manager	Sheep & Beef	6200	9	40-50	yes	yes	n/a	

44	External	manager	Dairy	250	4	40-50	yes	no	n/a	
45	External	shared owner-operator	Sheep & Beef	2500	5	30-40	yes	yes	unsure	
46	Network	owner-operator	Mixed	360	2	30-40	yes	yes	unsure	
47	Network	owner-operator	Sheep & Beef	750	2	40-50	yes	yes	unsure	
48	External	owner-operator	Mixed	325	2	30-40	yes	yes	unsure	
49	External	owner-operator	Sheep & Beef	630	3	50-60	yes	yes	no	Avoiders
50	Network	owner-operator	Dairy	130	3	30-40	yes	no	no	
51	Network	owner-operator	Arable	600	1	50-60	yes	yes	no	
52	Network	owner-operator	Mixed	430	2.5	30-40	yes	yes	unsure	

Appendix D. Supplementary material for Paper 4

1. An overview of the farmers included in the interviews of Paper 4.

Table 13. Overview of the 52 New Zealand interviewees who participated in the research for Paper 4.

Respondent	Participant group	Position	Type of farm	Size (ha)	Age (years)	Succession (yes/no/unsure)
1	FRNL	manager	Dairy	353	20-30	n/a
2	FRNL	general manager	Dairy	>1000	40-50	n/a
3	Network	manager	Dairy	304	20-30	n/a
4	FRNL	owner-operator	Sheep & Beef	370	50-60	unsure
5	FRNL	shared owner-operator	Arable	1400	30-40	unsure
6	FRNL	owner-operator	Arable	500	30-40	unsure
7	FRNL	owner-operator	Sheep & Beef	442	40-50	unsure
8	FRNL	owner-operator	Arable	490	60-70	no
9	Network	owner-operator	Sheep & Beef	320	50-60	yes
10	Network	owner-operator	Sheep & Beef	1000	50-60	unsure
11	FRNL	equity manager	Dairy	540	40-50	n/a
12	External	owner	Dairy	230	30-40	unsure
13	External	owner-operator	Dairy	928	50-60	yes
14	Network	owner-operator	Dairy	218	50-60	yes
15	External	Owner-operator	Dairy	290	40-50	unsure
16	Network	equity-manager	Dairy	200	20-30	n/a
17	Network	equity manager	Dairy	840	30-40	n/a
18	External	equity-manager	Dairy	202	50-60	n/a
19	External	owner-operator	Arable	350	60-70	no
20	Network	owner-operator	Arable	300	40-50	unsure
21	External	owner-operator	Dairy	406	70-80	yes
22	External	owner-operator	Arable	225	40-50	unsure
23	External	owner-operator	Sheep & Beef	920	30-40	unsure
24	FRNL	shared owner-operator	Dairy	1400	30-40	unsure
25	FRNL	owner-operator	Dairy	650	50-60	yes
26	FRNL	owner-operator	Dairy	823	50-60	yes
27	FRNL	manager	Dairy	310	30-40	n/a
28	Network	manager	Dairy	314	30-40	n/a
29	External	owner-operator	Arable	480	50-60	yes
30	Network	owner-operator	Arable	192	30-40	unsure
31	Network	shared owner-operator	Sheep & Beef	870	20-30	unsure
32	Network	owner-operator	Dairy	268	50-60	n/a
33	External	shared owner-operator	Sheep & Beef	930	40-50	unsure
34	External	equity owner farm manager	Dairy	338	50-60	yes

35	External	owner-operator	Dairy & arable	700	60-70	yes
36	External	owner-operator	Arable	210	50-60	unsure
37	External	owner-operator	Dairy	365	40-50	unsure
38	External	managing director	Dairy	1500	50-60	yes
39	External	owner-operator	Arable	200	40-50	unsure
40	External	manager	Dairy	398	30-40	no
41	External	owner-operator	Sheep & Beef	482	40-50	unsure
42	Network	owner-operator	Dairy	210	30-40	unsure
43	Network	manager	Sheep & Beef	6200	40-50	n/a
44	External	manager	Dairy	250	40-50	n/a
45	External	shared owner-operator	Sheep & Beef	2500	30-40	unsure
46	Network	owner-operator	Mixed	360	30-40	unsure
47	Network	owner-operator	Sheep & Beef	750	40-50	unsure
48	External	owner-operator	Mixed	325	30-40	unsure
49	External	owner-operator	Sheep & Beef	630	50-60	no
50	Network	owner-operator	Dairy	130	30-40	no
51	Network	owner-operator	Arable	600	50-60	no
52	Network	owner-operator	Mixed	430	30-40	unsure

Table 14. Overview of the 20 Scottish interviewees who participated in the research for Paper 4.

Respondent	# of PEP meetings attended	Position	Type of farm	Size of farm (ha)	Age (years)	Successor (yes/no)
1	>3	Owner-operator	mixed farm	194	50-60	yes
2	>3	Owner-operator	mixed livestock	500	50-60	no
3	>3	Owner-operator	arable	170	30-40	no
4	>3	Owner-operator	arable	165	70-80	yes
5	2 to 3	Owner-operator	arable	300	60-70	no
6	2 to 3	Owner-operator	mixed livestock	15	50-60	yes
7	2 to 3	owner-operator	arable	29	50-60	no
8	2 to 3	owner-operator	mixed farm	202	60-70	yes
9	>3	owner-operator	forage	60	60-70	no
10	>3	owner-operator	mixed livestock	220	60-70	yes
11	2 to 3	Owner-operator	dairy	240	50-60	no
12	>3	Owner-operator	forage	52	50-60	no
13	>3	owner-operator	dairy	160	60-70	yes
14	2 to 3	owner-operator	mixed farm	242	50-60	no
15	2 to 3	Owner-operator	mixed farm	222	50-60	no
16	>3	Owner-operator	mixed farm	53	50-60	no
17	2 to 3	Owner-operator	beef	440	60-70	no
18	>3	Owner-operator	dairy	250	50-60	yes
19	2 to 3	manager	mixed farm	11000	50-60	no
20	2 to 3	owner-operator	mixed farm	360	60-70	yes